

AD-A082 660

WOODWARD-CLYDE CONSULTANTS PLYMOUTH MEETING PA
NATIONAL DAM INSPECTION PROGRAM. RAILROAD CREEK
JAN 80 W F BECK, J H FREDERICK

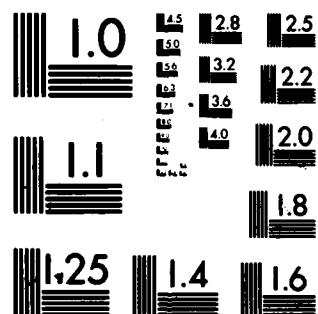
F/6 13/13
DAM (NDS ID NUM--ETC(U)
DACW31-80-C-0018

UNCLASSIFIED

NL

1 x 2
4x5000





MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

DISCLAIMER NOTICE

**THIS DOCUMENT IS BEST QUALITY
PRACTICABLE. THE COPY FURNISHED
TO DTIC CONTAINED A SIGNIFICANT
NUMBER OF PAGES WHICH DO NOT
REPRODUCE LEGIBLY.**

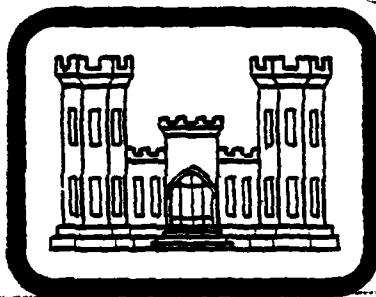
1

DELAWARE RIVER BASIN

(6) National Dam Inspection Program
RAILROAD CREEK DAM
~~BUCKS COUNTY, PENNSYLVANIA~~

(NDS I D NO. PA 01062,
DER I D NO. 9-175,
SCS NO. PA 615)

Tricounty to West Branch Mechanicsburg, PA
Bucks County, Pennsylvania
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



(10) 1/15/80, F.T.C.
John H. F. d. 1/15/80

(15) DACW/21-8X-C-1117

Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(11) JANUARY 1980

12145

314154

THIS document has been approved
for public release and sale; its
distribution is unlimited.

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

| | |
|---------------|-----------------------|
| Accession For | PTIS |
| DLC TAG | Unannounced |
| Justification | By |
| Distribution | Availability |
| Dist | Available for Special |
| APR 1963 | |

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

| | |
|---------------------|--|
| Name of Dam: | Railroad Creek Dam |
| County Located: | Bucks County |
| State Located: | Pennsylvania |
| Stream: | Unnamed Tributary to West Branch of Neshaminy Creek |
| Coordinates: | Latitude 40° 17.2' Longitude 75° 14.0' |
| Date of Inspection: | October 25, 1979 |

Railroad Creek Dam is owned by the Neshaminy Water Resources Authority and maintained by Bucks County. The dam and reservoir are used as a flood control structure for the downstream town of Chalfont, Pennsylvania. The impoundment was designed by the United States Department of Agriculture, Soil Conservation Service (SCS) in 1972 and 1973, and the structure was officially completed in 1977.

The dam and its appurtenant facilities are considered to be in good condition. The dam is classified as an "Intermediate" size structure with a "High" hazard classification, consistent with its potential in the event of failure for extensive property damage and loss of life in Chalfont, Pennsylvania.

Calculations indicate that the existing spillway systems are capable of passing the Probable Maximum Flood (PMF) without overtopping. Therefore, the spillway system is considered to be "Adequate".

The visual inspection and review of available documentation indicates that the dam, foundation and its appurtenant structures are in good condition and the embankment materials were placed in accordance with specification requirements. The vegetation is in poor condition, but no significant damage has resulted to the embankment itself. It was noted that the aluminum trash rack channels are bent and an angle bar is missing from the pond drain trash rack. An electric cattle fence is located along the upstream toe and berm of the dam and across the emergency spillway.

In addition to the annual maintenance of the structure, it is recommended that the following suggestions be implemented as specified. It is recommended that the following step be taken immediately.

1. The electric cattle fence should be moved upstream of the riser away from the embankment toe.

The following measures should be taken as soon as practical.

2. The vegetative cover on the embankment should be reestablished in a satisfactory manner.
3. The missing angle on the pond drain trash rack and the bolts on the embankment drain outlets should be replaced.

Because of the location of the dam upstream of Chalfont, a formal procedure of observation and warning during periods of high precipitation has been developed. The Owner also has an "Operations Manual" and maintenance procedures. It is important that individuals responsible for the maintenance and operation of Railroad Creek Dam are aware of the written procedures to insure that all items are carefully inspected and maintained on a periodic basis.

Mary F. Beck

Mary F. Beck, P.E.
Pennsylvania Registration 27447E
Woodward-Clyde Consultants

Feb. 7, 1980

Date

John H. Frederick, Jr.
John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants



2/7/80

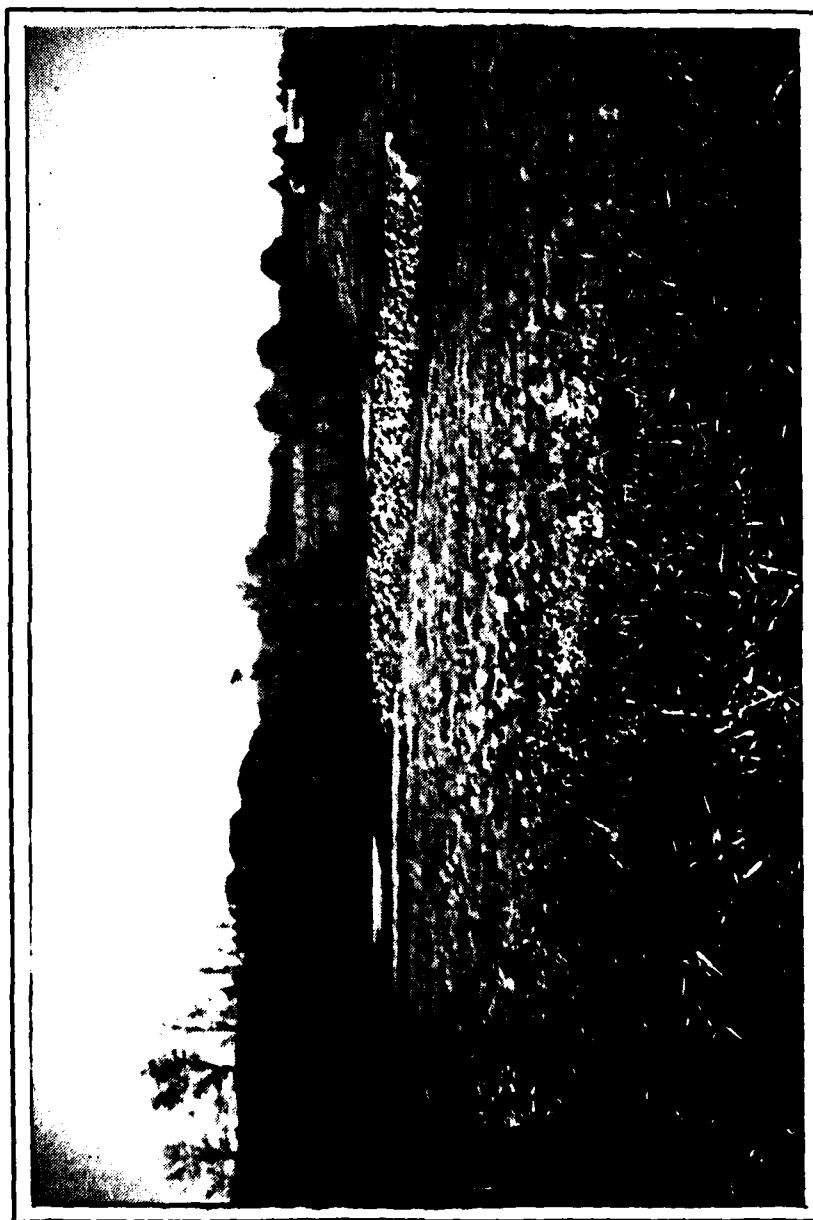
Date

APPROVED BY:

Thomas A. Rhen
THOMAS A. RHEN
LTC, Corps of Engineers
Acting District Engineer

20 March 80

Date



OVERVIEW
RAILROAD CREEK DAM, BUCKS COUNTY, PENNSYLVANIA

TABLE OF CONTENTS

| | <u>PAGE</u> |
|---|-------------|
| Preface | i |
| Assessment and Recommendations | ii |
| Overview Photograph | iv |
| SECTION 1 - PROJECT INFORMATION | |
| 1.1 General | 1 |
| 1.2 Description of Project | 1 |
| 1.3 Pertinent Data | 3 |
| SECTION 2 - ENGINEERING DATA | |
| 2.1 Design | 6 |
| 2.2 Construction | 6 |
| 2.3 Operational Data | 6 |
| 2.4 Evaluation | 7 |
| SECTION 3 - VISUAL INSPECTION | |
| 3.1 Findings | 8 |
| 3.2 Evaluation | 10 |
| SECTION 4 - OPERATIONAL PROCEDURES | |
| 4.1 Procedures | 11 |
| 4.2 Maintenance of the Dam | 11 |
| 4.3 Maintenance of Operating Facilities | 11 |
| 4.4 Warning Systems In Effect | 11 |
| 4.5 Evaluation | 12 |
| SECTION 5 - HYDROLOGY/HYDRAULICS | |
| 5.1 Evaluation of Features | 13 |
| SECTION 6 - STRUCTURAL STABILITY | |
| 6.1 Evaluation of Structural Stability | 15 |
| SECTION 7 - ASSESSMENT/REMEDIAL MEASURES | |
| 7.1 Dam Assessment | 18 |
| 7.2 Remedial Measures | 18 |
| APPENDIX | |
| A Visual Inspection | |
| B Engineering Data, Design, Construction and Operation | |
| C Photographs | |
| D Hydrology/Hydraulics | |
| E Plates | |
| F Geology | |

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
RAILROAD CREEK DAM
(SCS PA 615)
NATIONAL ID NO. PA 01062
DER NO. 9-175

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Railroad Creek Dam is a 34 foot-high zoned earth embankment about 1,170 feet long with an emergency spillway at the left end of the embankment. The embankment contains an impervious core constructed over a cutoff trench under the dam centerline. The core and cutoff trench are composed of materials classified as silty clays and clayey silts (Zone 1) and encompassed by more permeable materials classified as silty gravels (Zone 2). The upstream slope is 3H:1V with a ten foot berm at approximately elevation 267. The downstream slope is 2.5H:1V. The upstream and downstream slopes of the relatively impervious Zone 1 core are 1.5H:1V. The embankment crest is 14 feet wide and has a settled fill elevation of 292.2. Both upstream and downstream slopes are protected with Crownvetch. Embankment seepage is controlled by a trench drain near the downstream toe which contains 12 inch diameter perforated drain pipes that discharge through the impact basin sidewalls at the downstream toe. Plan and cross-section views of the dam are shown on Plates 2 through 5, Appendix E, and embankment drainage details are shown on Plate 7.

The principal spillway consists of a concrete drop inlet riser, 202 feet of 30 inch diameter reinforced concrete, steel cylinder pressure pipe, with seven anti-seep collars and an impact basin at the downstream toe. The reservoir drain located at the base of the riser has an invert elevation of

258.75, and the elevation of the riser weirs is 267.5. The outlet invert and impact basin end sill elevations are 256.0. Because of high pressure gas lines which cross the reservoir area, the pond drain gate is not closed and water is not normally impounded behind the dam. Typical sections and details of the principal spillway are presented on Plates 8 through 13 in Appendix E. The emergency spillway is a trapezoidal channel excavated around the left end of the embankment. The 250 foot wide channel has side slopes of 3H:1V, and the 30 foot level section is at elevation 284.5.

b. Location. The dam is located on an unnamed stream, known locally as Railroad Creek, a tributary to the West Branch of Neshaminy Creek in New Britain Township, Bucks County, Pennsylvania. The dam is located approximately one mile west of Chalfont, Pennsylvania. The dam site is located on USGS Quadrangle entitled "Doylestown, Pennsylvania", at coordinates N 40° 17.2' W 75° 14.0'. A regional location plan of Railroad Creek Dam is included as Plate 1, Appendix E.

c. Size Classification. The dam is classified as an "Intermediate" size dam by virtue of its 1,610 acre-foot total storage capacity.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the potential for extensive property damage and loss of life along the West Branch of Neshaminy Creek downstream of the dam.

e. Ownership. Railroad Creek Dam is owned by Neshaminy Water Resources Authority. All correspondence should be sent to Mr. William Taylor, Neshaminy Water Resources Authority, Post Office Box 6, Cross Keys Office Center, 4259 Swamp Road, Doylestown, Pennsylvania 18901.

f. Purpose of Dam. The purpose of this dam is flood control. The structure is one of ten dams in the Neshaminy Creek Watershed that are scheduled for construction with the assistance of the United States Department of Agriculture, Soil Conservation Service (SCS). This is the sixth project of the series.

g. Design and Construction History. The dam was designed by the SCS in 1972 and 1973. The application to construct a flood control dam and reservoir was submitted April 19, 1974. A letter of the same date from the Neshaminy Water Resources Authority to the Pennsylvania Department of Environmental Resources notes that, "in order to accommodate the requirements of the Texas Eastern Company gas transmission mains which cross the reservoir, the sedimentation pool will be left empty and there will not be a permanent water pool." The "Report upon the Application" was issued by the State of

Pennsylvania on January 14, 1976. The project was approved by the Delaware River Basin Commission in July of 1976, and construction began in early 1977 by Thomas Durkin & Sons. The dam was officially completed December 7, 1977.

Records in the Department of Environmental Resources files indicate that all work was performed in a satisfactory manner. Documents prepared by SCS personnel indicate that results of the in-place density test on the Zone 1 (core) material all exceed at least 95 percent of the Standard Proctor maximum density (ASTM D 698). Compaction of the Zone 2 (shell) material was by method specification requiring at least six passes with a 450 psi tamping roller per maximum 18 inch lift. Complete construction records are on file with SCS in Harrisburg.

The embankment was seeded during an exceptionally mild spell in late October 1977, toward the end of the seeding period. At least some of the seed germinated and was subsequently frozen during the following winter. SCS has prepared a reseeding plan to be implemented in the spring or early summer of 1980.

SCS is investigating replacement of aluminum trash rack channels with steel channels. The channels were bent by ice during the first winter when the reservoir level was high during a rapid freeze.

h. Normal Operating Procedures. Reservoir outflow is controlled by the principal and emergency spillways. Under normal conditions, water flows through the principal spillway. The pond drain gate is left open and no water is impounded behind the embankment. Excess water is stored up to the weir crest elevation, 267.5, and thereafter to elevation 284.5, the crest of the emergency spillway. Water is discharged through the emergency spillway at the left abutment only during storms with recurrence frequencies of once in 100 years.

1.3 Pertinent Data.

A summary of pertinent data for Railroad Creek Dam is presented as follows.

| | | |
|----|---------------------------------|---------|
| a. | Drainage Area (square miles) | 3.39 |
| b. | Discharge at Dam Site (cfs) | |
| | Maximum Known Flood at Dam Site | Unknown |
| | Design High Water | 2,290 |
| | At Top of Dam | 15,120 |

| | | |
|----|--------------------------------|---|
| c. | Elevation (feet above MSL) | |
| | Top of Dam | 292.2 |
| | Design High Water | 287.5 |
| | Emergency Spillway Crest | 284.5 |
| | Principal Spillway | |
| | Weir Crest | 267.5 |
| | Pond Drain Inlet Invert | 258.75 |
| | Outlet Invert | 256.0 |
| | Downstream Toe | 258.0 |
| d. | Reservoir (miles) | |
| | Length at Normal Pool | Dry |
| | Length at Design High Water | 0.9 |
| e. | Storage (acre-feet) | |
| | Sediment | 50 |
| | To Top of Dam | 1,610 |
| f. | Reservoir Surface Area (acres) | |
| | Sediment Pool | 13 |
| | Design High Water | 110 |
| g. | Dam Data | |
| | Type | Zoned earth embankment |
| | Volume | 88,400 cu yds |
| | Length | 1,170 feet |
| | Maximum Height | 34 feet |
| | Top Width | 14 feet |
| | Side Slopes | |
| | Upstream | 3H:1V |
| | Downstream | 2.5H:1V |
| | Cutoff | Trench under centerline |
| | Grout Curtain | None |
| h. | Principal Spillway | |
| | Type | Single stage reinforced concrete drop inlet riser, 30 inch conduit and impact basin |
| | Reservoir drain | At base of riser |
| | Elevation | |
| | Weirs | 267.5 |
| | Pond Drain Inlet Invert | 258.75 |
| | Conduit Outlet Invert | 256.0 |
| | Energy Dissipator | Impact basin |

i. Emergency Spillway
Type

Width
Side Slopes

Grass lined trape-
zoidal channel
250 feet
3H:1V

SECTION 2 ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of the available engineering data on SCS PA 615, known as Railroad Creek Dam, is attached as Appendix B. Engineering data available for review is contained in a several hundred page design folder and a 37 page set of as-built plans. The design folder and plans are located in Soil Conservation Service (SCS) files and as-built drawings are also located in Department of Environmental Resources (DER) and the Owner's files. All of these records were prepared by the United States Department of Agriculture, Soil Conservation Service. Additional information was obtained from miscellaneous letters, correspondence and monthly construction reports in DER files.

b. Design Features. The principal design features of Railroad Creek Dam are illustrated on the plans and profiles enclosed in Appendix E as Plates 2 through 13. A detailed description of the design features is also described in Section 1.2, paragraph a, and pertinent data relative to the structure is presented in Section 1.3. In addition to the plans of the dam, Plates 14 and 15 are enclosed to show the locations of the test borings and the results of typical compaction tests performed as part of the design.

2.2 Construction.

Construction history is presented in Section 1.2, paragraph g. Construction records are located in DER and SCS files, and specific aspects of construction were obtained from the Neshaminy Water Resources Authority's representative and the SCS project engineer.

2.3 Operational Data.

There are no operational records maintained. There are no minimum flow requirements for the downstream channel. There are no water level measurements or rainfall records maintained within the watershed although Neshaminy Water Resources Authority maintains a rain gauge at their office in Cross Keys, Pennsylvania.

2.4 Evaluation.

a. Availability. All engineering data evaluated and reproduced for this report were provided by either DER or SCS and supplemented by conversations and data obtained from representatives of the Neshaminy Water Resources Authority.

b. Adequacy. Data included in State files, supplemented with data obtained from the Neshaminy Water Resources Authority and information received from State and Authority representatives, are considered adequate to evaluate the dam and appurtenant structures.

c. Validity. There is no reason to question the validity of this data.

SECTION 3 VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A, and are summarized and evaluated as follows. In general, the dam and its appurtenant structures are considered to be in good condition, with the exception of the vegetative cover to the embankment. At the time of the inspection, stream flow was passing through the riser of the principal spillway.

b. Dam. During the visual inspection, there were no indications of distortion in alignment or grade that would be indicative of movement of the embankment or foundation. Vegetative cover on the embankment is considered in poor condition, with patchy areas, particularly at the maximum section. At the time of inspection, there was very little damage evident as a result of the poor vegetative cover. An electric cattle fence is located along the upstream toe and berm of the dam and across the emergency spillway. At the present time, no damage to the embankment has resulted. However, it is recommended that the fence be moved away from the embankment to prevent possible future damage from grazing cattle, particularly during a dry summer.

The vertical and horizontal alignments were checked and found to be satisfactory. Junctions between the embankment and abutment and the embankment and spillway were judged to be in good condition with no excessive erosion or deterioration. Clear seepage was observed entering the downstream channel below the impact basin from the right. An area to the left of the impact basin contains grass and vegetation indicative of a wet area. As the reservoir is dry, seepage is judged to be the result of hillside seepage. The upstream berm was wet and soft and appears not to drain well. Embankment drains outletting through the walls of the impact basin were dry.

c. Appurtenant Structures.

1. Principal Spillway. As shown on the plates, the riser is located at the upstream toe of the embankment. The exposed portions of the riser were inspected and evaluated to be in good condition with no signs of excessive concrete deterioration, spalling or other structural deficiency or defects. As shown in Photograph 9, an angle is missing from the pond drain trash rack. Photograph 8 shows that aluminum channels forming the upper stage trash rack are bent. The

channels were bent by ice during the winter of 1977-78. At the time of inspection, the low stage trash rack was clear of debris, although some debris was noted at the stream edge. By December, this debris had collected in the trash rack. The pond drain gate was exercised and was observed to seal completely. The impact basin at the downstream toe was inspected and found to be in good condition with no significant cracking or spalling of the concrete or erosion adjacent to the structure. The embankment drains outlet through walls of the impact basin. The bolts used as small animal guards were missing and should be replaced. The downstream channel was also inspected and found to be in good condition with no significant erosion or deterioration.

2. Emergency Spillway. The grass-lined emergency spillway at the left abutment was inspected and found to be stable and in good condition. Rainwater/hillside seepage was observed on the left side of the emergency spillway floor. Small trees and scrub brush was observed at the discharge end of the emergency spillway. The owners plan on having them removed shortly.

d. Reservoir. At the time of the inspection, no water was impounded behind the embankment. The pond drain is open permitting base flow to pass through the principal spillway. The reservoir slopes are well vegetated to the stream's edge. Debris was observed along the stream.

e. Downstream Channel. As shown on Plate 1, Appendix E, Railroad Creek flows eastward and empties into the West Branch of Neshaminy Creek about 3,500 feet below the dam. About 0.75 miles below the confluence, the West Branch flows under U.S. Route 202 and through Chalfont before joining the North Branch. Two other dams also provide flood protection for Chalfont. Peace Valley Dam, which is on the North Branch of Neshaminy Creek, and Pine Creek Dam, built across Pine Creek, a tributary to the North Branch. Between Railroad Creek Dam and the West Branch, the stream's 20 foot wide channel is stable with a valley gradient of about 0.005. Where Route 202 crosses the West Branch of Neshaminy Creek, there are at least six homes or businesses subject to damage in the event of dam failure, including one gasoline station protected by a dike on Route 202. Upstream of Route 202 is one factory and at least one other house that would be damaged or flooded in the event of failure. Railroad Creek Dam, in conjunction with Peace Valley Dam and Pine Run Dam, was designed to protect Chalfont, a highly populated area, from flood damage. Therefore, a "High" hazard classification is justified for Railroad Creek Dam.

3.2 Evaluation.

Inspection of the dam and appurtenant facilities disclosed no evidence of apparent past or present movement that would indicate existing instability of the dam, principal spillway or emergency spillway. The exposed portions of the riser and impact basin were inspected, and the principal spillway is judged to be in good condition, with bent trash rack channels and a missing angle iron from the pond drain trash rack noted. The emergency spillway is considered to be in good condition. The embankment is considered to be in good condition although the vegetation cover is poor. The overall condition of the dam is considered good.

SECTION 4 OPERATIONAL PROCEDURES

4.1 Procedures.

Operational procedures are discussed in some detail in Section 1.2. Operation of the dam does not require a dam tender. Under normal conditions, flow discharges through the pond drain and through the 30 inch conduit at the base of the embankment. Excess water is stored and then discharged over the principal spillway riser weirs and through the conduit. Additional excess water is then stored and discharged over the crest of the emergency spillway. As reported by the Owner's representatives, water has never flowed over the emergency spillway. Written operation and maintenance procedures used by Neshaminy Water Resources Authority are contained in "State of Pennsylvania Watersheds and Resource Conservation and Development Operation and Maintenance Handbook for Projects Installed with Assistance from the Soil Conservation Service" and specific procedures for each site are contained in the "Operations Manual" prepared by William G. Major Associates, Inc., June 1977.

4.2 Maintenance of the Dam.

The dam is maintained by Bucks County personnel who periodically check the embankment, mow the grass and remove woody vegetation. As owner of the dam, Neshaminy Water Resources Authority monitors the maintenance performed and assists if possible. Neshaminy Water Resources Authority recently supplied CETA workers who removed debris from the reservoir area.

4.3 Maintenance of Operating Facilities.

Maintenance of these facilities includes cleaning debris from the trash racks, lubricating the gate hoist and checking the structural integrity of the principal spillway system.

4.4 Warning Systems In Effect.

A draft warning procedure, dated January 1980, has been prepared by the local Civil Defense office. The draft has been submitted to both the Neshaminy Water Resources Authority and the State Office of Civil Defense in Harrisburg for review.

4.5 Evaluation.

It is judged that the current operating procedure, which does not require a dam tender, is a realistic means of operating the relatively simple control facilities at Railroad Creek Dam.

The "Operations Manual" prepared by William D. Majors Associates, Inc., summarizes the control features and the responsible agency for operation and maintenance of each project within the Neshaminy Watershed constructed by 1977. Although the operational philosophy for a single-purpose flood control structure is contained in the manual, a "fact sheet" pertaining to Railroad Creek Dam is required. It is important that individuals responsible for the maintenance and operation of Railroad Creek Dam are aware of the written procedures to insure that all items are carefully inspected and maintained on a periodic basis.

SECTION 5 HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. The complete folder of design calculations was reviewed, and portions of this folder are presented in Appendix C.

The watershed is about 2.5 miles long, and from 0.8 to 2.2 miles wide, having a total area of approximately 3.39 square miles. Elevations range from 660 in the upper reaches of the watershed to about 258.8 at the pond drain inlet elevation. The watershed is predominantly open/farmland, with less than 10 percent residential development. Residential development can be expected to progress rapidly.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard classification is the Probable Maximum Flood (PMF). The Soil Conservation Service designed this dam as a Class C structure, which requires that the spillway systems be designed to pass the PMF.

b. Experience Data. There are no records of reservoir levels kept for this dam. Rainfall is measured and records are kept at the Neshaminy Water Resources Authority's office in Cross Keys, Doylestown, Pennsylvania. There are no estimates or records of previous high water levels.

c. Visual Observations. On the date of the inspection, there were no conditions observed that would indicate a reduced spillway capacity during an extreme event. Observations regarding the condition of the downstream channel, spillways and reservoir are located in Appendix A and are discussed in greater detail in Section 3.

d. Overtopping Potential. The dam was designed to pass the PMF without overtopping. The PMF inflow hydrograph and flood routing were done according to procedures in the SCS National Engineering Handbook. The flood routing was originally done by a graphical procedure. Subsequently, after land rights for the structure had been obtained, the flood routing was checked by the SCS computer program, TR-20, the results of which are included in Appendix C. The computer routing indicated a top of dam of 292.87 feet, about 0.7 foot higher than the current elevation. As land rights were obtained before the computer routing was performed, it was decided to lower the emergency spillway elevation by 0.5 foot and to retain the original flood routing as a basis for design.

Because of the differences in the flood routing by TR-20, the spillway adequacy was evaluated as part of this investigation according to standards established for the National Dam Inspection Program. Overtopping potential of the dam was estimated using the HEC-1, Dam Safety Version, computer program. A brief description of the program is included in Appendix D. Calculations for this investigation confirm the original design spillway discharge of about 15,000 cfs with the reservoir at the top of the embankment. The HEC-1 program computed the peak PMF inflow to be about 10,260 cfs. As the spillway capacity is greater than the computed peak PMF inflow, flood routing was not necessary. Spillway systems for this dam are considered to be "Adequate" as the dam will pass the PMF without overtopping.

e. Downstream Conditions. Downstream conditions and damage centers have been discussed in Section 3. In general, Railroad Creek Dam, together with Peace Valley Dam and Pine Run Dam controlling the upper reaches of the North Branch of Neshaminy Creek, provides relief from flooding in a rapidly urbanizing area. However, the SCS Neshaminy Watershed work plan concludes that a high potential for flood damage still exists downstream of these structures in Chalfont. It is estimated that damage from flooding has been reduced but not eliminated through control of the upper reaches of the Neshaminy Watershed by flood control structures. In conclusion, it is evaluated that a significant increase in downstream damage would result from failure of the dam during a PMF than damage resulting from large flows during passage of the PMF.

SECTION 6 STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations detected no evidence of existing or pending embankment instability. Upstream and downstream slopes appear stable, with no surficial slides or indications of deep seated instability. Both the upstream and downstream slopes are poorly vegetated with Crownvetch and require reseeding. There are no exterior signs or other evidence to indicate that the internal drainage systems were not operating properly. It is noted, however, that during this inspection, the reservoir was empty and the embankment was not retaining a significant head of water which could affect the internal drainage system.

Seepage and wet areas were observed at the downstream toe. However, as there was no water behind the embankment, the seepage and wet areas are judged to be the result of hillside seepage rather than seepage through or under the embankment.

Exposed portions of the principal spillway were inspected and judged to be in good condition. The emergency spillway was also inspected and assessed to be in good condition.

b. Design and Construction Data. Design documentation is very complete as a several hundred page design folder prepared by the Soil Conservation Service (SCS) was available and reviewed at their office for this investigation. Data included in these files are a foundation report containing permeability test results, shear strength test results and a stability analysis, structural calculations for the principal spillway and a complete set of hydrologic/hydraulic calculations. Portions of the Hydrology/Hydraulics section are presented in Appendix D. Principal features of this structure are presented in the drawings located in Appendix E. Also included in the design folder are a complete set of specifications and an estimate of the quantity of material used in the embankment.

A stability analysis of the embankment was performed by SCS using the ICES-LEASE computer program. Soil parameters were based upon a total of five consolidated-undrained triaxial compression tests, with pore pressure measurements, conducted on compacted Zone 1 and Zone 2 embankment materials. The foundation materials were assumed to have sufficient strength to prevent potential failure arcs from passing through the foundation. The shear strength parameters adopted

for design were reviewed and are judged to be conservative, based on the test results. Stability analyses using the Swedish circle method resulted in the following minimum factors of safety:

| <u>Slope</u> | <u>Condition</u> | <u>Minimum Factor of Safety</u> |
|--------------|---------------------|---------------------------------|
| Upstream | Rapid Full Drawdown | 1.51 |
| Downstream | Steady Seepage | 1.52 |

The recommended allowable factors of safety for these conditions, in accordance with Corps of Engineers EM 1110-2-1902 are 1.2 and 1.5, respectively.

It is noted that the phreatic line assumed for the stability analysis corresponds to that which would occur for a homogeneous embankment. Since the embankment actually contains a relatively impervious core, the actual phreatic line would be higher on the upstream side and lower on the downstream side. This would cause an increase in the downstream (steady seepage) factor of safety and a decrease in the upstream (rapid drawdown) factor of safety. Since the upstream factor of safety is well above minimum, this decrease is not considered critical. Furthermore, the steady state and drawdown water level was assumed to be elevation 284.5, the emergency spillway crest elevation, rather than the highest principal spillway crest elevation, 267.5, as specified by current SCS criteria in TR-60. Therefore, it is concluded that the stability of the embankment is adequate.

Documents pertaining to construction also include a 37 sheet set of drawings prepared by the SCS and stamped "as-built". The progress reports prepared by the SCS resident engineer and inspection reports prepared by DER representatives indicate that work was performed in accordance with SCS requirements and that all in-place density test results exceeded the minimum specification of 95 percent of the Standard Proctor maximum density as defined by ASTM D 698.

c. Operating Records. There are no operational records for this structure.

d. Post-Construction Changes. There are no reports, nor is there any evidence, that modifications were made to this dam.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be

assumed safe for any expected earthquake conditions. As the stability analysis resulted in a minimum factor of safety of 1.51 during rapid drawdown, the most critical loading condition, it can be assumed that seismic stability requirements are satisfied.

SECTION 7 ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection and review of design and construction documentation indicate that the dam, foundation and appurtenant structures of Railroad Creek Dam are in generally good condition. The hydrologic and hydraulic computations presented in Appendix D indicate that the structure will pass the Probable Maximum Flood without overtopping. Therefore, the spillway systems of this structure are considered to be "Adequate". In the event that high flows are passed through the emergency spillway, significant property damage is still likely to occur along the West Branch of Neshaminy Creek and especially in the town of Chalfont, Pennsylvania, where there are many homes on or near the flood plain. In the event the dam fails while retaining a significant quantity of water, extreme property damage and possible loss of life would be expected.

b. Adequacy of Information. The information available for this investigation was sufficiently adequate to evaluate the structural and hydraulic aspects of the dam.

c. Urgency. It is recommended that the suggestions presented in Section 7.2 be implemented as specified.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following step be taken immediately.

1. The electric cattle fence should be moved upstream of the riser away from the embankment toe.

The following measures should be taken as soon as practical.

2. The vegetative cover on the embankment should be reestablished in a satisfactory manner.
3. The missing angle on the pond drain trash rack and the bolts on the embankment drain outlets should be replaced.

b. Operation and Maintenance Procedures. Neshaminy Water Resources Authority has an "Operations Manual" specifying agencies responsible for operation and maintenance for Neshaminy Watershed projects completed by 1977. The manual requires updating to include Railroad Creek Dam. The

Operations Manual refers to "Development Operation and Maintenance Manual" prepared by SCS for a maintenance inspection checklist, which should be used to insure that all items are periodically inspected and maintained in the best possible condition. It is recommended that these procedures provide for a period of observation during and following impoundment of significant quantities of water behind the embankment. These observations should include monitoring discharge from the embankment drainage system and looking for sources of uncontrolled seepage.

A warning system has been drafted and is in the process of review. This warning procedure should include monitoring of the dam during periods of high precipitation and a method of warning and evacuating residents along the creek, if necessary.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Sheet 1 of 11

Name Dam Railroad Creek Dam County Bucks State Pennsylvania National ID # PA 01062
Type of Dam Earth Hazard Category High
Date(s) Inspection 10/25/79 Weather Clear Temperature Cool

Pool Elevation at Time of Inspection Dry H.S.L. Tailwater at Time of Inspection H.S.L.

Inspection Personnel:

Mary Beck (Hydrologist) Vincent McKeever (Hydrologist)

Arthur Drinoff (Geotechnical)

Raymond S. Lambert (Geologist)
11/30/79

Mary F. Beck Recorder

Remarks:

Messrs. William Taylor and Charles Burger of the Neshaminy Water Resources Authority and
Mr. Eugene McGough of William D. Majors Associates, Inc., were on site and provided assistance
to the inspection team. Messrs. Brent Higgins and Bob Herbine of the local Civil Defense
Unit were also on site.

CONCRETE/MASONRY DAMS

Sheet 2 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|--|--------------|----------------------------|
| ANY NOTICEABLE SEEPAGE | N/A | |
| STRUCTURE TO ABUTMENT/UPSTREAM JUNCTIONS | N/A | |
| DRAINS | N/A | |
| WATER PASSAGES | N/A | |
| FOUNDATION | N/A | |

CONCRETE/MASONRY DAMS

Sheet 3 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|--------------------------------------|--------------|----------------------------|
| SURFACE CRACKS CONCRETE SURFACES | N/A | |
| STRUCTURAL CRACKING | N/A | |
| VERTICAL AND HORIZONTAL ALIGNMENT | N/A | |
| MAJOR ITM JOINTS | N/A | |
| CONSTRUCTION JOINTS | N/A | |

EMBANKMENT

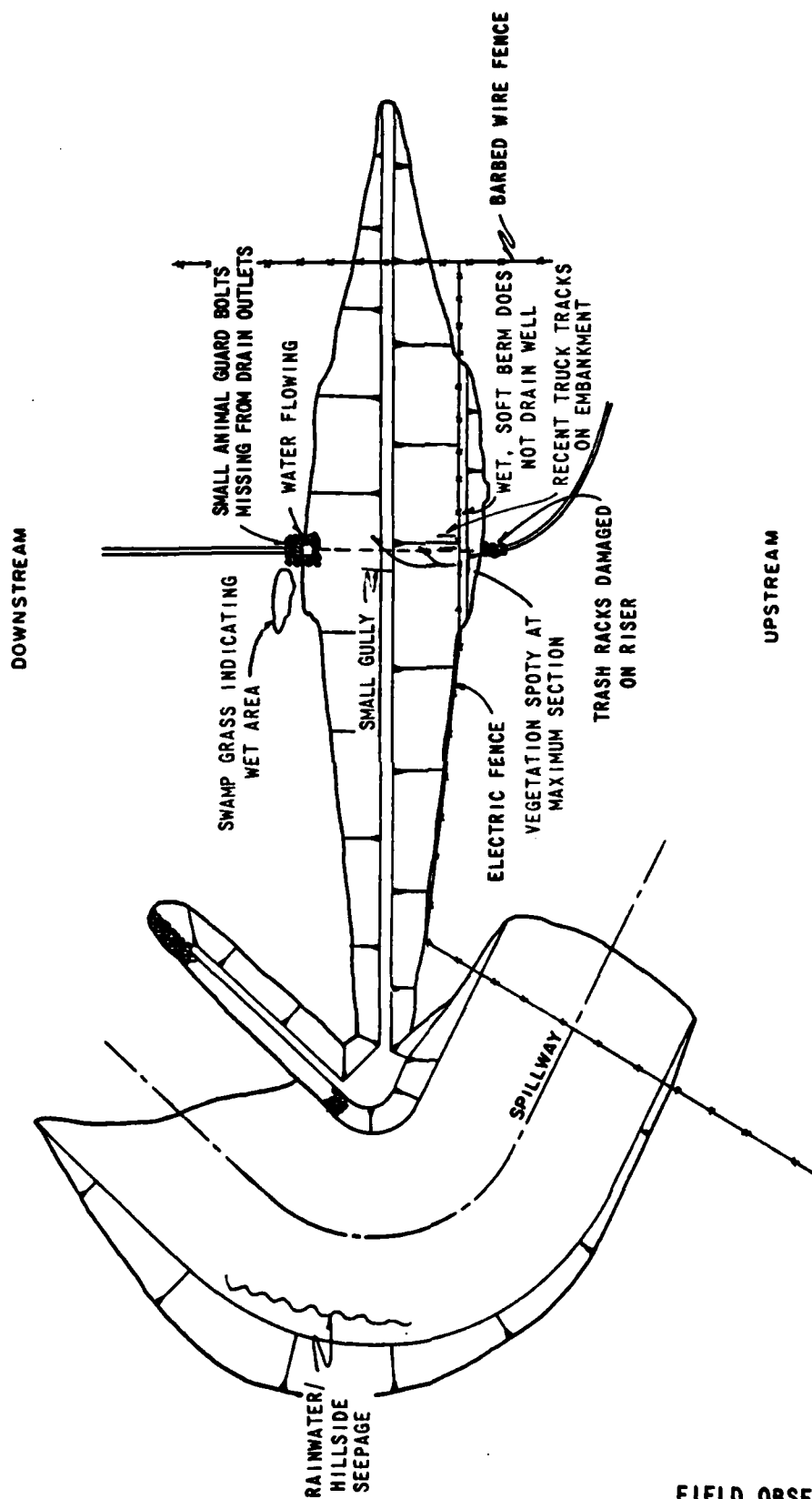
Sheet 4 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|--|---|----------------------------|
| SURFACE CRACKS | <i>None observed.</i> | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | <i>None observed.</i> | |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | <i>Vegetation is sparse along the crest and on both upstream and downstream slopes at maximum section. Reseeding required. Almost no damage has resulted as a result of lack of vegetation. Slight damage (one set of tracks) made by truck or similar vehicle on upstream face near riser.</i> | |
| VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST | <i>The vertical and horizontal alignment was checked and found to be satisfactory.</i> | |
| RIPRAP FAILURES | <i>N/A</i> | |

EMBANKMENT

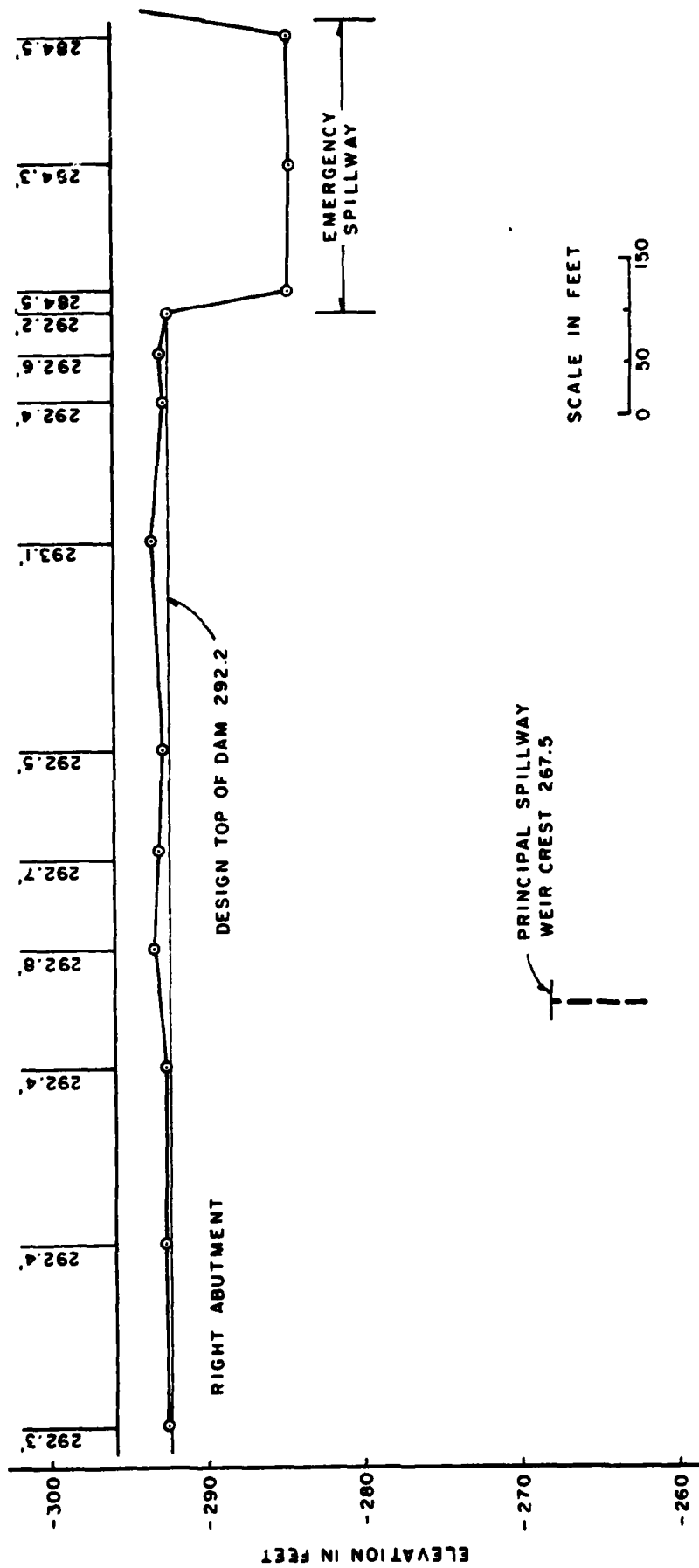
Sheet 5 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|----------------------------|
| MISCELLANEOUS | <i>An electric fence at the upstream toe and berm of the embankment allows cattle to graze in the reservoir and part of the emergency spillway. Currently, little or no damage has resulted from cattle traffic but damage is possible, particularly during a dry summer. It is recommended that the fence be moved away from the embankment toe.</i> | |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | <i>All junctions of embankment and abutments in good condition.</i> | |
| ANY NOTICEABLE SEEPAGE | <i>None, dry reservoir, see Sheet 5A.</i> | |
| STAFF GAGE AND RECORDER | <i>None</i> | |
| DRAINS | <i>Dry, bolts (small animal guards) missing, should be replaced.</i> | |



FIELD OBSERVATION PLAN
RAILROAD CREEK DAM

SHEET 5A OF 11



SCALE IN FEET

0 50 150

LOOKING UPSTREAM

FIELD OBSERVATION PROFILE RAILROAD CREEK DAM

SHEET 5B OF 11

PRINCIPAL SPILLWAY
OUTLET WORKS

Sheet 6 of 11

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|--|---|-----------------------------------|
| CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT | Conduit is underground and could not be inspected. | |
| INTAKE STRUCTURE | Good, trash rock channels bent, reportedly from ice. One angle is missing from pond drain trash rack. | |
| OUTLET STRUCTURE | Good condition, bolts (small animal guards) missing from embankment drain outlets (through side walls). | |
| OUTLET CHANNEL | The channel immediately below the impact basin is in good condition. | |
| EMERGENCY GATE | Operates easily and seats completely. | |

EMERGENCY SPILLWAY

UNGATED SPILLWAY

Sheet 7 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|-----------------------|--------------|----------------------------|
|-----------------------|--------------|----------------------------|

CONTROL SECTION

Spillway is a grass-lined trapezoidal channel.

APPROACH CHANNEL

Good condition.

DISCHARGE CHANNEL

Good condition. Small trees and scrub brush at end of discharge channel. Owners plan on having them removed shortly.

BRIDGE AND PIERS

None

GATED SPILLWAY

Sheet 8 of 11

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|-------------------------------|---------------------|-----------------------------------|
| CONCRETE STILL | N/A | |
| APPROACH CHANNEL | N/A | |
| DISCHARGE CHANNEL | N/A | |
| BRIDGE AND PIERS | N/A | |
| GATES AND OPERATION EQUIPMENT | N/A | |

INSTRUMENTATION

Sheet 9 of 11

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION

MONUMENTATION/SURVEYS

No monuments installed, a post-construction survey of dam crest is included in Appendix E.

OBSERVATION WELLS

None

WEIRS

None

PIEZOMETERS

None

OTHER

None

RESERVOIR

Sheet 10 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|-----------------------|--------------|----------------------------|
|-----------------------|--------------|----------------------------|

SLOPES

Reservoir side slopes are flat to moderate. Well vegetated with trees and grass.

SEDIMENTATION

No sedimentation observed.

DOWNSTREAM CHANNEL

Sheet 11 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|-----------------------|--------------|----------------------------|
|-----------------------|--------------|----------------------------|

CONDITION

(OBSTRUCTIONS,
DEBRIS, ETC.)

The 12 foot wide channel meanders through a wooded flood plain. Channel sides range from 8H:1V on inside of bends to nearly vertical on the cutting side.

SLOPES

The valley gradient is approximately 0.005.

APPROXIMATE NO. OF HOMES AND POPULATION

About 3,500 feet below the dam, Railroad Creek enters the West Branch of Neshaminy Creek. About 0.75 mile below the confluence, the West Branch flows under U.S. Route 202 and through Chalfont before joining the North Branch. In Chalfont there are at least six homes/businesses subject to damage in the event of dam failure, including one gas station protected by a dike on Route 202.

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Railroad Creek Dam
ID # PA 01062

ITEM

REMARKS

Sheet 1 of 4

AS-BUILT DRAWINGS

Drawings presented in Appendix E are "As-Built" drawings.

REGIONAL VICINITY MAP

See Plate 1, Appendix E.

CONSTRUCTION HISTORY

See Section 1.2 of text.

TYPICAL SECTIONS OF DAM

See Appendix E.

OUTLETS - PLAN

DETAILS

CONSTRAINTS

DISCHARGE RATINGS

RAINFALL/RESERVOIR RECORDS

Rainfall is measured by Neshaminy Water Resources Authority at their office in Cross Keys about six miles northeast of the dam.

| ITEM | REMARKS |
|---|--|
| DESIGN REPORTS | <i>See discussion in Section 1 of text.</i> |
| GEOLOGY REPORTS | <i>See Appendix F.</i> |
| DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES | <i>See discussion in Sections 5 and 6 of text.</i> |
| MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD | <i>Complete records in SCS files.</i> |
| POST-CONSTRUCTION SURVEYS OF DAM | <i>A final crest profile survey was performed. Data is presented on Plate 6, Appendix E.</i> |
| BORROW SOURCES | <i>Data located on SCS drawings.</i> |

| ITEM | REMARKS |
|---|--|
| MONITORING SYSTEMS | <i>None</i> |
| MODIFICATIONS | <i>All pertinent modifications are noted on the "As-Built" drawings presented in Appendix E.</i> |
| HIGH POOL RECORDS | <i>None</i> |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | <i>None</i> |
| PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS | <i>None</i> |
| MAINTENANCE OPERATION RECORDS | <i>Neshaminy Water Resources Authority maintains these files.</i> |

| ITEM | REMARKS |
|---------------|-----------------------------|
| SPILLWAY PLAN | See Appendix E for details. |
| SECTIONS | |
| DETAILS | |

See Appendix E for details.

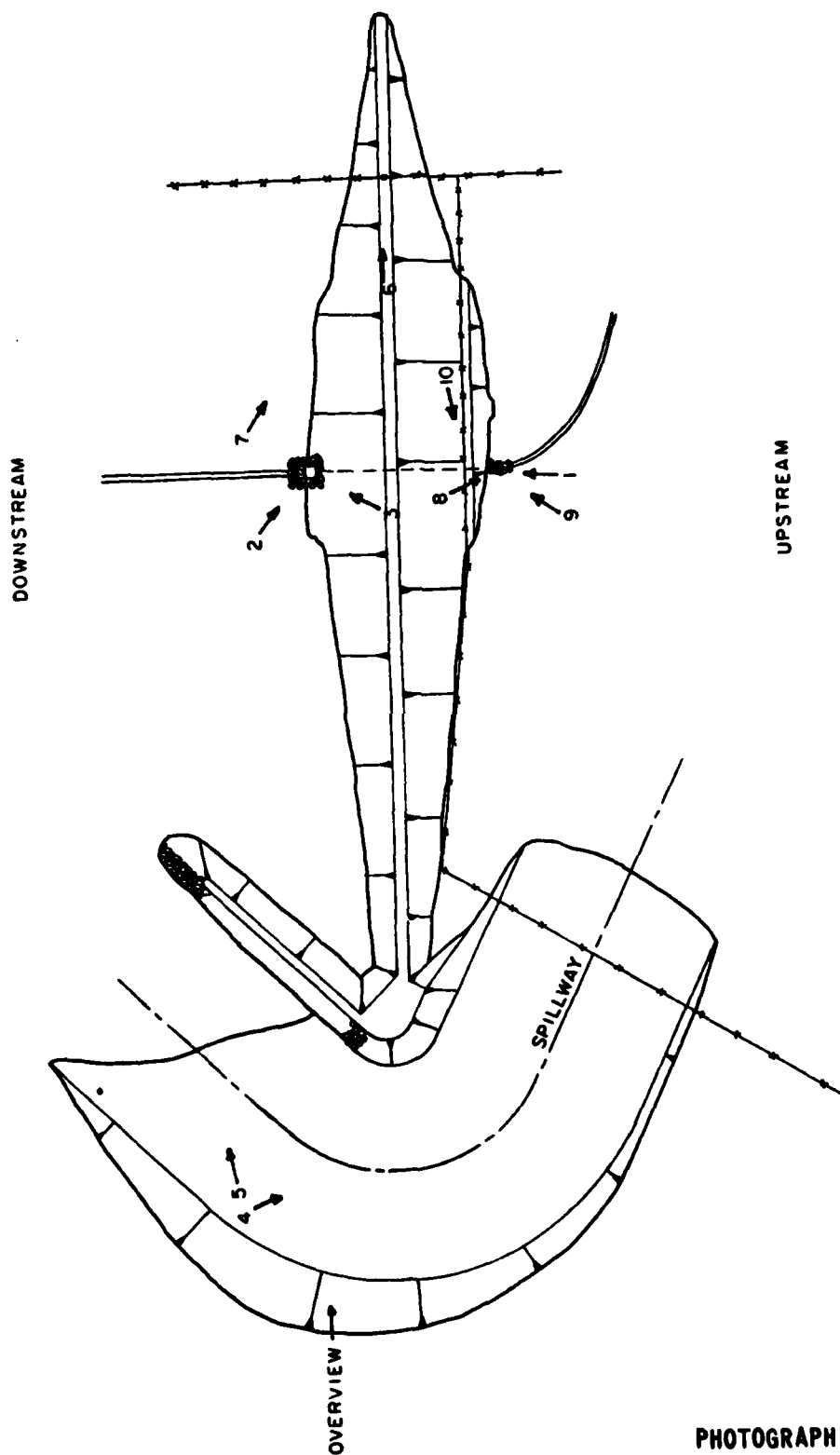
OPERATING EQUIPMENT
PLANS & DETAILS

MISCELLANEOUS

1. Report Upon the Application of the Neshaminy Water Resources Authority submitted by the State of Pennsylvania, January 14, 1976.
2. Permit issued by State of Pennsylvania, January 21, 1976.
3. 37 design drawings prepared by SCS, 1973-1974.
4. Erosion and Sediment Control Plan prepared by SCS, September, 1974.
5. Progress Reports by Frederick Schueta, Project Engineer, SCS.
6. Inspection Report prepared by the State.
7. 29 color photographs taken by DER Inspectors.
8. Special Operation and Maintenance Report by SCS, August 15, 1978.

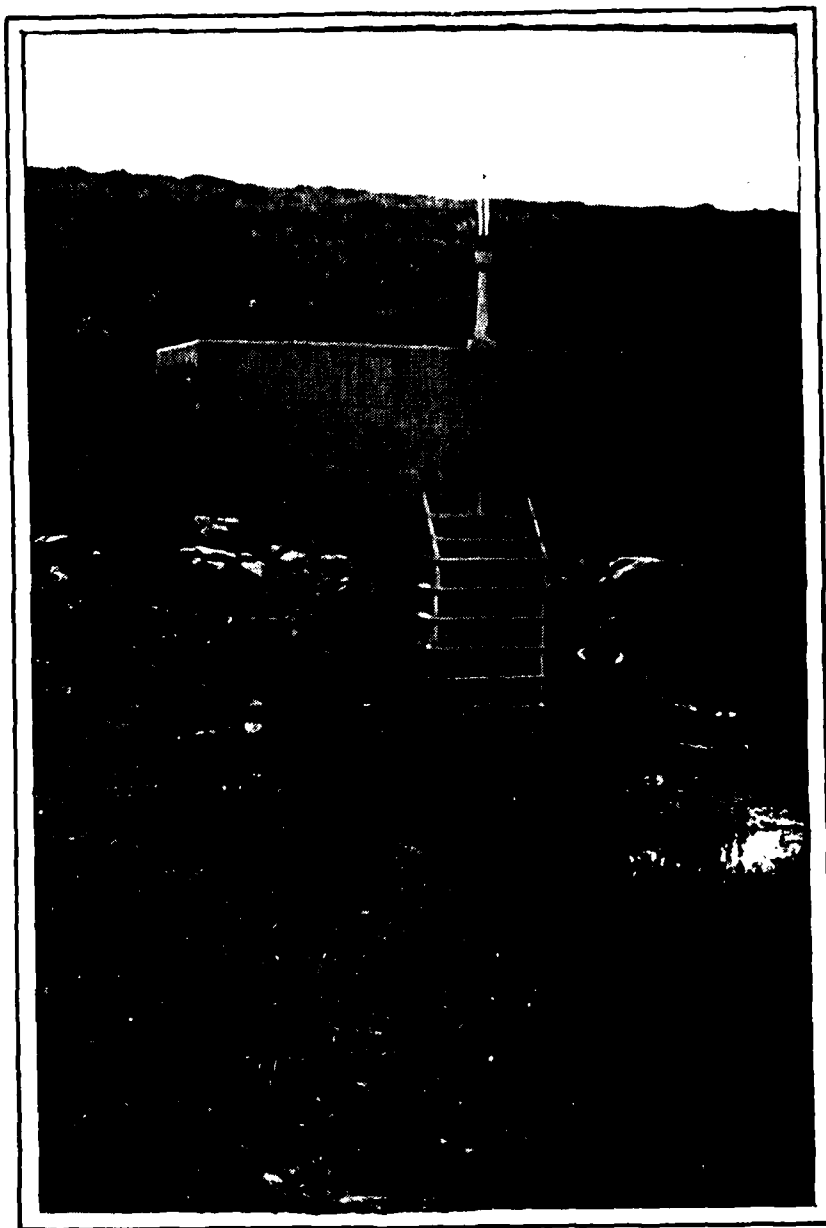
APPENDIX

C



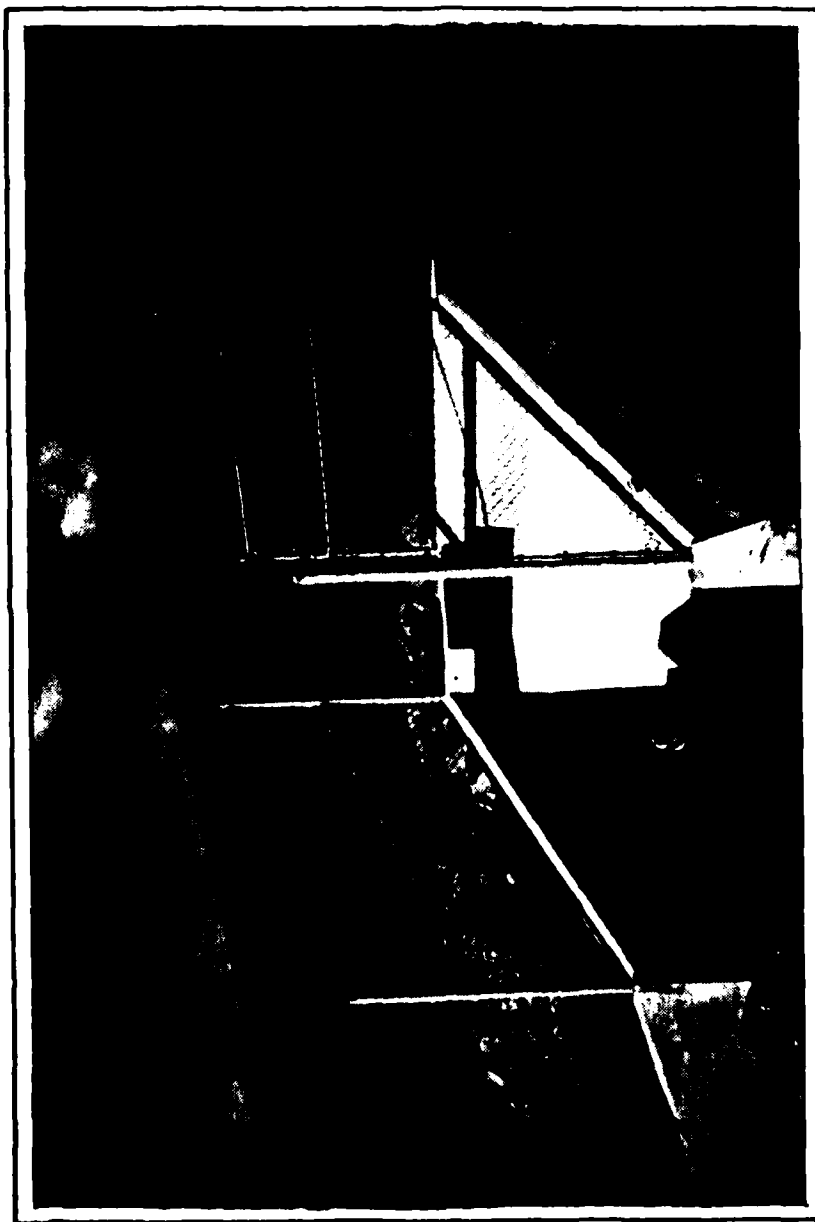
PHOTOGRAPH LOCATION PLAN
RAILROAD CREEK DAM

PLATE C-1



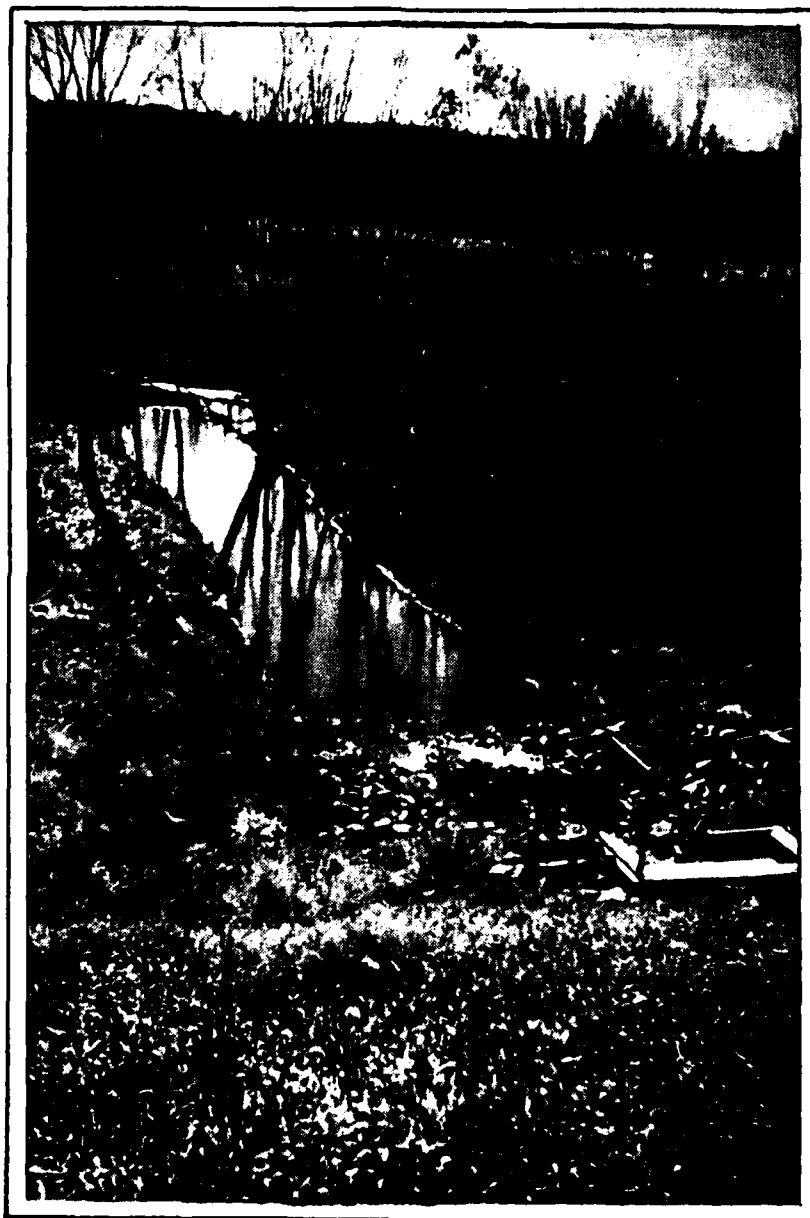
PRINCIPAL SPILLWAY RISER
WITH OPEN POND DRAIN GATE.

PHOTOGRAPH NO. 1



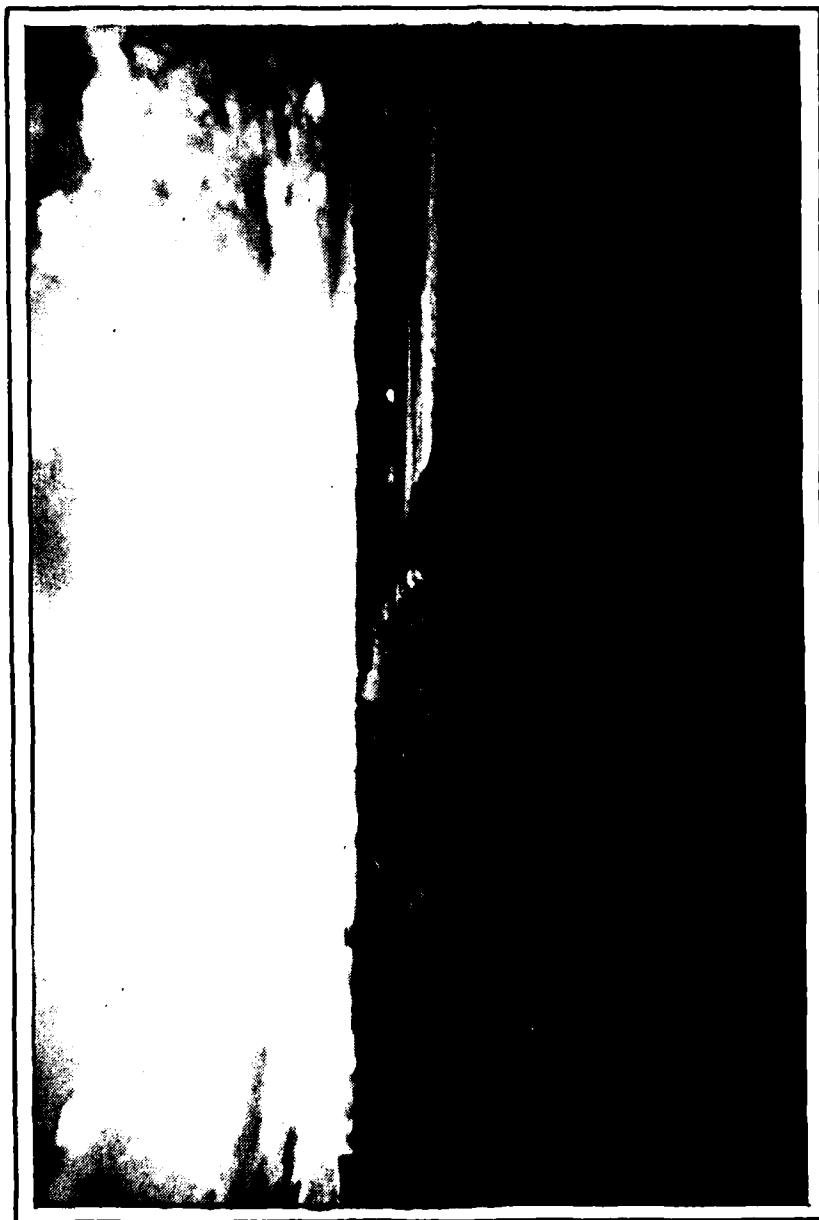
PRINCIPAL SPILLWAY IMPACT BASIN.
BOLTS (SMALL ANIMAL GUARD) ARE
MISSING FROM EMBANKMENT DRAIN
OUTLETS.

PHOTOGRAPH NO. 2



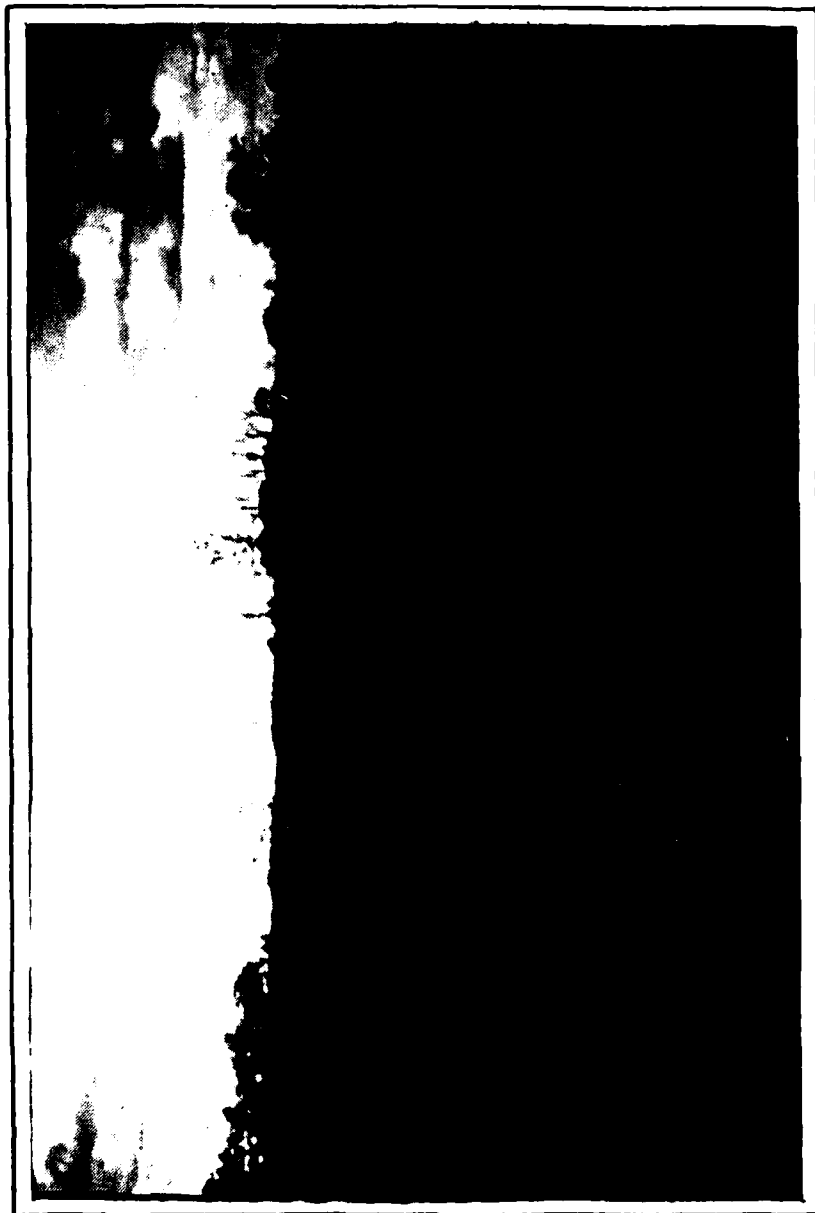
VIEW FROM TOP OF DAM SHOWING
IMPACT BASIN AND DOWNSTREAM
CHANNEL.

PHOTOGRAPH NO. 3



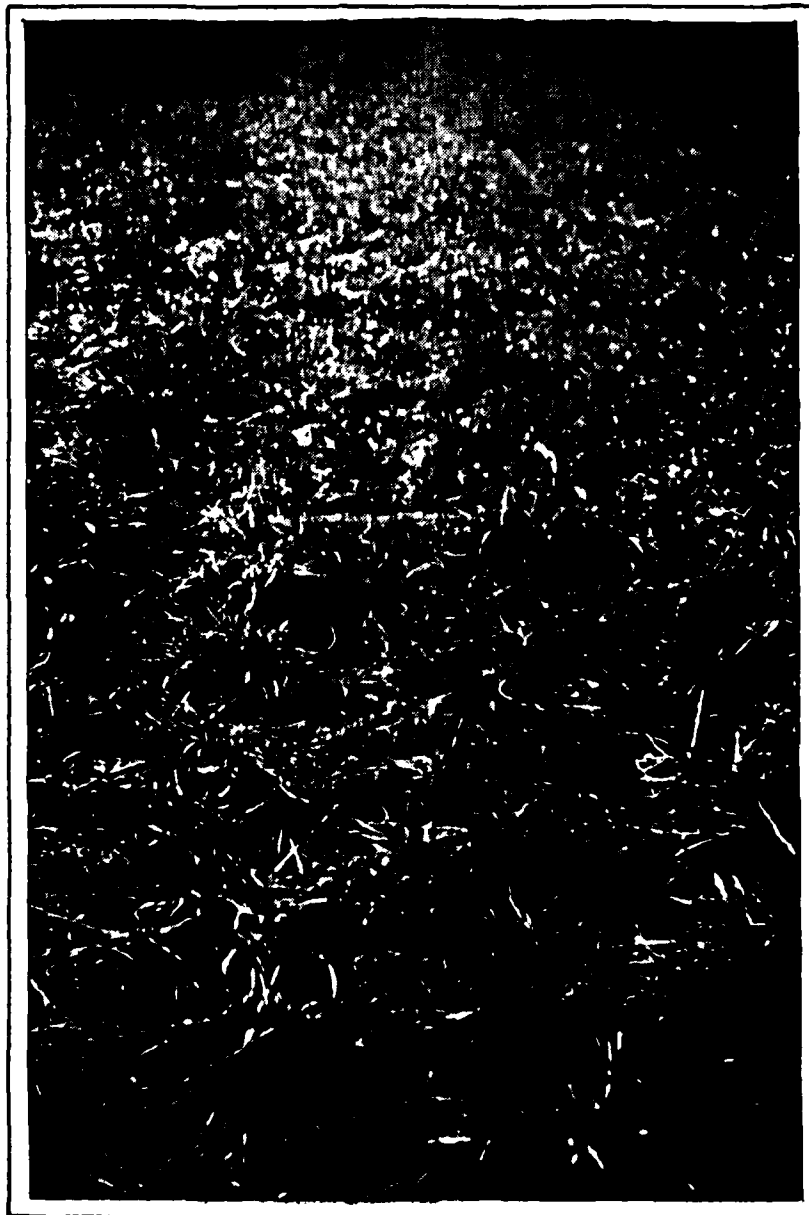
VIEW OF EMERGENCY SPILLWAY FROM
LEFT ABUTMENT LOOKING UPSTREAM.

PHOTOGRAPH NO. 4



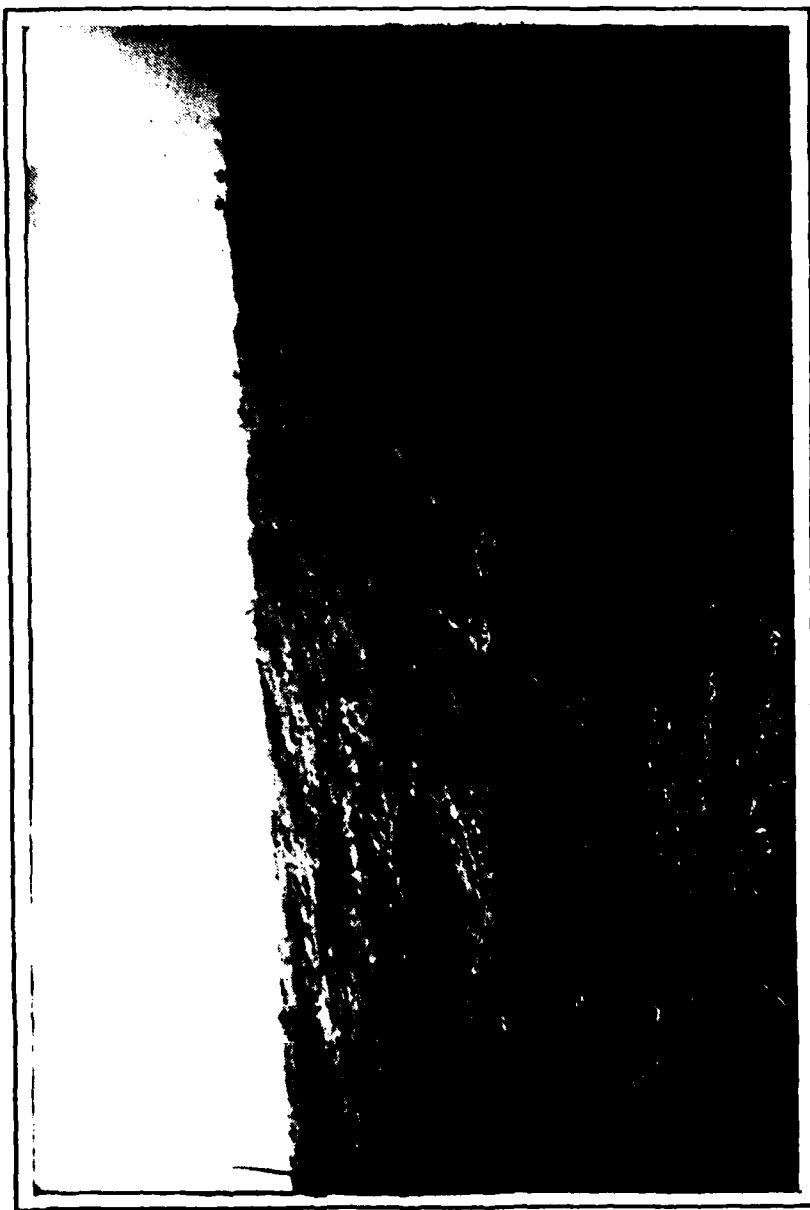
VIEW OF EMERGENCY SPILLWAY FROM
LEFT ABUTMENT LOOKING DOWNSTREAM.

PHOTOGRAPH NO. 5



VIEW OF CREST, MINOR DAMAGE TO
CREST FROM TRUCK TRAFFIC

PHOTOGRAPH NO. 6



OVERVIEW OF DOWNSTREAM SLOPE. NOTE
FENCE POSTS AT CREST OF DAM.

PHOTOGRAPH NO. 7



TRASH RACK CHANNELS, REPORTEDLY
DAMAGED BY ICE.

PHOTOGRAPH NO. 8



POND DRAIN TRASH RACK WITH MISSING
ANGLE.

PHOTOGRAPH NO. 9



ELECTRIC FENCE AT UPSTREAM TOE.

PHOTOGRAPH NO. 10



SECOND DOWNSTREAM HIGHWAY BRIDGE
AND DAMAGE CENTER. PICTURE TAKEN
FROM DIKE PROTECTING GASOLINE
STATION TO THE RIGHT OF THE PICTURE.

PHOTOGRAPH NO. 11

APPENDIX

D

RAILROAD CREEK DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: About 25% wooded, less than 10% residential,
remainder is open/farm land.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 267.5 feet (50 Acre-Feet).

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 292.2 feet (1610 Acre-Feet).

ELEVATION MAXIMUM DESIGN POOL: 287.5 feet Design High Water.

ELEVATION TOP DAM: 292.2 feet.

EMERGENCY SPILLWAY:

- a. Elevation 284.5 feet.
- b. Type Grass lined trapezoidal channel.
- c. Width 250 feet.
- d. Length About 800 feet.
- e. Location Spillover At left abutment
- f. Number and Type of Gates None

PRINCIPAL SPILLWAY:

- a. Type Drop inlet riser, 30-inch conduit and impact basin.
- b. Location Dam station 19+90, at maximum section.
- c. Entrance inverts Riser weirs at 267.5 feet.
- d. Exit inverts 256.0 feet.
- e. Emergency draindown facilities Pond drain inlet at 258.75 feet.

HYDROMETEOROLOGICAL GAGES:

- a. Type Standard rain gage.
- b. Location Neshaminy Water Resources Authority office at Cross Keys,
Pennsylvania.
- c. Records Kept at Cross Keys.

MAXIMUM NON-DAMAGING DISCHARGE: Not estimated.

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quadrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are input and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

Railroad Creek Dam
Hydrology/Hydraulics

Classification (Ref. - Recommended Guidelines for Safety
Inspection of Dams)

1. The hazard potential is rated as "High" as there would be loss of life if the dam failed.
2. The size classification is "Intermediate" based 1610 Acre-Feet total storage capacity.
3. The spillway design flood, based on size and hazard classification, is the Probable Maximum Flood (PMF).

Hydrologic/Hydraulic Analysis

The complete H & H design folder was available for review. The PMF inflow hydrograph was determined according to procedures in the SCS National Engineering Handbook, Section 4 (NEH-4). The routing was done according to procedures in NEH-5 (not available for review) and, later, checked by SCS computer program, TR-20. The computer routing indicated a higher maximum water elevation than the original flood routing. As land rights were obtained before the computer routing, it was decided to lower the emergency spillway elevation and retain the original flood routing as basis of design. It was decided to evaluate the spillway adequacy using the HEC-1, Dam Safety Version, computer program.

Original design parameters were checked against current information and/or criteria. The drainage area of 3.39 square miles is verified by current USGS maps.

Calculations for the PMF inflow hydrograph were based on a 6-hour rainfall of 25.5 inches and a Runoff Curve Number of 80. Rainfall criteria established for this investigation by the Corps of Engineers indicate a 26.6 inch rainfall (Ref. Hydrometeorological Report No. 33) and the use of Rop Brook Factor, a point rainfall reduction factor. For a watershed of this size, the point rainfall

is reduced by 20%, to 21.1 inches. Thus, the design rainfall is conservative compared to Corps of Engineers criteria. The Runoff Curve Number 80 (CN 80) is based on the hydrologic soil group classification and expected future land use within the watershed. The future land use was based on projections of the Bucks and Montgomery Planning Commission to year 2010. Projected land use includes farm/open, 15.15%; wooded, 12.5%; and residential, 72%. The estimated current developed areas are less than 10% from the 1973 USGS map. The estimated future conditions are judged adequate.

The emergency spillway discharge was checked according to current SCS criteria, TR-39. The maximum emergency spillway discharge was estimated as 15,000 cfs (see sheet 5), about the same as emergency spillway discharge used in the SCS computer routing. The maximum capacity of the reservoir used in the computer routing was somewhat less than the value from the calculations in the design folder. The capacity values reported are less than the actual values as the borrow sources were from within the reservoir area.

Snyder's hydrograph parameters, t_p and c_p , shown on sheet 5, were used to determine the PMF inflow hydrograph. The peak inflow value is estimated as 10,360 cfs, less than the emergency spillway capacity, therefore, no reservoir routing was required.

The spillway is rated as "Adequate" as the spillways will pass the PMF without overtopping the embankment.

BY MFB DATE 12/10/79 SUBJECT Railroad Creek Dam SHEET 5 OF 12
 CHKD. BY DATE Hydrology / Hydraulics JOB No.

Emergency Spillway Capacity ref TR-39

bottom width = 250 ft.
 level section = 30 ft
 total length ~ 600 ft
 approach channel slope = 0.01

assume $Q = 15,000 \text{ cfs}$
 $q = Q/b = 60 \text{ cfs/ft}$

depth at upstream edge of level section = 5.7 ft.

ES-158, sh. 1 of 10

depth @ entrance to approach channel = 13.5 ft

ES-158, sh. 2 of 10

velocity head at entrance ~ 0.19

ES-159, sh. 1 of 2

total head at entrance to approach channel =

elevation + water depth + velocity head

$= 278.4 + 13.5 + 0.19 = 292.1 \text{ ft}$ close to
 292.2 ft, maximum
 water elevation.

$\therefore Q \sim 15,000 \text{ cfs}$

Snyder's hydrograph parameters, $t_p \neq C_p$

$$t_p = C_t (L \cdot L_{ca})^{0.3}$$

$$C_t = 1.50$$

$$C_p = 0.81$$

} from correlation studies by Corps of
 Engineers, Batt. Dist., for zone 6

$$L = 2.98 \text{ miles}$$

$$L_{ca} = 1.28 \text{ miles}$$

} from U.S.G.S map.

$$t_p = 1.50 (2.98 \cdot 1.28)^{0.3}$$

$$= 2.24$$

12/21/64 JDG

PA 615 NESHAMINY

9 of

STAGE STORAGE COMPUTATIONS

(DAM IN PLACE)

$$1" = 180.79 \text{ Ac-ft.}$$

$$1 \text{ in}^2 = 0.918 \text{ Ac}$$

| STAGE | AREA SQ IN | AREA AC | Σ AREA AC | AVG AREA AC | DIST FT | VOL AC FT | CUM VOL AC FT | |
|-------------------|-----------------|------------|--------------|-------------------|------------|--------------|---------------------|------------------------|
| 258 | 0 | 0 | | | | | 0 | |
| | | | 0.86 | 0.43 | 2 | 1 | | |
| 260 | 0.94 | 0.86 | | | | | 1 | |
| | | | 8.66 | 4.33 | 5 | 22 | | |
| 265 | 8.52 | 7.8 | | | | | 23 | |
| | | | 26.7 | 13.35 | 5 | 67 | | |
| 270 | 20.54 | 18.9 | | | | | 90 | |
| | | | 53.5 | 26.75 | 5 | 134 | | |
| 275 | 37.70 | 34.6 | | | | | 224 | |
| | | | 92.2 | 46.1 | 5 | 231 | | |
| 280 | 62.69 | 57.6 | | | | | 455 | |
| | | | 146.4 | 73.2 | 5 | 366 | | |
| 285 | 96.63 | 88.6 | | | | | 821 | |
| | | | 217.8 | 108.9 | 5 | 545 | | |
| 290 | 140.17 | 129.0 | | | | | 1366 | |
| | | | 298.4 | 149.2 | 5 | 746 | | |
| 295 | 184.43 | 169.4 | | | | | 2112 | |
| Effective Storage | | | | | | | | |
| Elev | Σ Vol inches | | Elev | Eff Vol inches | Ac: Ft. | | | |
| 258 | 0 | | 267.5 | 0 | 0 | | | |
| 260 | 0.006 | | 270 | 0.20 | 36.2 | | | |
| 265 | 0.13 | | 275 | 0.89 | 160.9 | | | |
| 270 | 0.50 | | 280 | 2.17 | 392.3 | | | checked by JMR 2-18-65 |
| 275 | 1.24 | | 285 | 4.19 | 757.5 | | | |
| 280 | 2.52 | | 290 | 7.25 | 1310.7 | | | |
| 285 | 4.54 | | 295 | 11.33 | 2048.4 | | | |
| 290 | 7.55 | | | | | | | |
| 295 | 11.68 | | | | | | | |

REF:-
SCS DESIGN
FOLDER

E. S. DESIGN AND FREEBOARD ROUTINGS.

NESHAMINY CREEK PA-615

JHF 11-72

CURVE NO. 80. TC 1.53 STORM DURATION 6.00

EMER. SPW. RAINFALL 10.50 FREEBOARD RAINFALL 25.50

CASE NO. 0. DRAINAGE AREA 3.39 EMER. SPW. CREST 285.0

801 250. L1 500. B02 0. L2 0. B03 0. L3 0.

| ELEVATION | STORAGE | CFS | CFS | CFS |
|-----------|---------|--------|-----|-----|
| 285.00 | 821. | 107. | 0. | 0. |
| 287.00 | 1039. | 2482. | 0. | 0. |
| 289.00 | 1257. | 4857. | 0. | 0. |
| 289.26 | 1285. | 5165. | 0. | 0. |
| 290.29 | 1397. | 7617. | 0. | 0. |
| 291.00 | 1475. | 9724. | 0. | 0. |
| 292.33 | 1619. | 13671. | 0. | 0. |
| 293.00 | 1693. | 16098. | 0. | 0. |
| 294.36 | 1841. | 20025. | 0. | 0. |
| 294.99 | 1911. | 23716. | 0. | 0. |

REF:-
SCS DESIGN
FOLDER

80 → I = 250. L = 500. CREST = 285.00

| TIME | INFLOW | AVE IN | OUTFLOW | ELEV. |
|-------|--------|--------|---------|--------|
| 1.00 | 215. | 141. | 107. | 285.00 |
| 1.25 | 552. | 379. | 162. | 285.04 |
| 1.50 | 1081. | 812. | 293. | 285.15 |
| 1.75 | 1871. | 1476. | 532. | 285.35 |
| 2.00 | 3095. | 2483. | 926. | 285.48 |
| 2.25 | 5223. | 4159. | 1578. | 285.23 |
| 2.50 | 8638. | 6925. | 2655. | 287.14 |
| 2.75 | 12877. | 10756. | 4301. | 288.53 |
| 3.00 | 16507. | 14692. | 7426. | 290.20 |
| 3.25 | 18133. | 17320. | 11728. | 291.67 |
| 3.50 | 17578. | 17856. | 15511. | 292.57 |
| 3.75 | 15780. | 16679. | 18635. | 292.87 |
| 4.00 | 13751. | 14765. | 21190. | 292.74 |
| 4.25 | 11989. | 12870. | 24004. | 292.42 |
| 4.50 | 10519. | 11254. | 27500. | 292.01 |
| 4.75 | 9198. | 9858. | 31480. | 291.59 |
| 5.00 | 8024. | 8611. | 36221. | 291.16 |
| 5.25 | 7083. | 7553. | 40500. | 290.77 |
| 5.50 | 6380. | 6731. | 44332. | 290.42 |
| 5.75 | 5875. | 6128. | 47657. | 290.15 |
| 6.00 | 5466. | 5670. | 50477. | 289.89 |
| 6.25 | 5090. | 5227. | 52807. | 289.67 |
| 6.50 | 4719. | 4854. | 54793. | 289.44 |
| 6.75 | 4372. | 4495. | 56358. | 289.16 |
| 7.00 | 4031. | 4136. | 57508. | 288.82 |
| 7.25 | 3681. | 3772. | 58241. | 288.41 |
| 7.50 | 3304. | 3382. | 58536. | 287.97 |
| 7.75 | 2911. | 2973. | 58323. | 287.53 |
| 8.00 | 2500. | 2547. | 57646. | 287.13 |
| 8.25 | 2095. | 2137. | 56508. | 286.77 |
| 8.50 | 1701. | 1760. | 54917. | 286.46 |
| 8.75 | 1320. | 1372. | 52852. | 286.19 |
| 9.00 | 931. | 977. | 50327. | 285.96 |
| 9.25 | 561. | 586. | 47377. | 285.77 |
| 9.50 | 215. | 225. | 44074. | 285.47 |
| 9.75 | 80. | 85. | 40544. | 285.36 |
| 10.00 | 25. | 27. | 36838. | 285.27 |
| 10.25 | 8. | 8. | 32951. | 285.20 |
| 10.50 | 2. | 2. | 28981. | 285.14 |
| 10.75 | 0. | 0. | 24924. | 285.09 |
| 11.00 | 0. | 0. | 20974. | 285.00 |

Top of Dam
292.87 - Peak Occurs Previous Line

REF:-
SCS DESIGN
FOLDER

VOLUME CHECK AT HP IS 0.15 PERCENT.

COMPUTED HP 7.87

DURATION OF FLOW THRU EMERGENCY SPILLWAY = 10.79 HRS

THRU THE EMERGENCY SPILLWAY PER FOOT OF BOTTOM WIDTH 10/81 - AF/11 = 16.21

VOLUME OF OUTFLOW

PAUSE

By H. L. W. Date 11/23/74 Checked By AMIN L. PEEK Date 11/23/74 Job No. PA-615
 Subject: WORK PLAN - DESIGN COMPARISON Sheet 1 of 12

| ITEM | UNIT | WORK PLAN | DESIGN | COMMENTS |
|------------------------------------|---------|-----------|---------------|----------|
| <u>DRAINAGE AREA</u> | SQ. MI. | 3.37 | 3.39 | |
| <u>STORAGE CAPACITY</u> | | | | |
| SEDIMENT (INC. AERATED) | AC FT. | 63 | 63 | |
| BENEFICIAL | AC FT. | | | |
| RETARDING | AC FT. | 722 | 714.1 | |
| TOTAL | AC FT. | 785 | 777.1 | |
| BETWEEN HIGH & LOW S. | AC FT. | | | |
| <u>SURFACE AREA</u> | | | | |
| NORMAL POOL | ACRE | 13 | 13 | |
| RETARDING POOL | ACRE | 86 | 85 | |
| DESIGN HIGH WATER | ACRE | | 110 | |
| <u>VOLUME OF FILL</u> | CU YD. | 71,000 | | |
| <u>TOP OF DAM ELEV.</u> | FEET | 291.7 | 292.2 | |
| <u>MAX. HEIGHT OF DAM</u> | FEET | 34.7 | 35.2 | |
| <u>EMERGENCY SPILLWAY</u> | | | | |
| CREST ELEVATION | FEET | 284.6 | 284.5 | |
| BOTTOM WIDTH | FEET | 250 | 250 | |
| TYPE | - | 500 | 500 | |
| PERCENT CHANCE OF USE | - | 1 | 1 | |
| AVE. CURVE NO. COND. I | - | 80.0 | 80 | |
| <u>EM. SP. HYDROGRAPH</u> | | | | |
| STORM RAINFALL - 6 HR. | IN. | 10.5 | 10.5 | |
| STORM RUNOFF | IN. | 9.0 | 9.0 | |
| VELOCITY OF FLOW - V | FPS | 7.2 | 7.2 | |
| PEAK DISCHARGE RATE | CFS | 2,200 | 2,288 | |
| MAX. WATER SURFACE EL. | FEET | 292.1 | 292.5 | |
| <u>FREEBOARD HYDROGRAPH</u> | | | | |
| STORM RAINFALL - 6 HR. | IN. | 25.5 | 25.5 | |
| STORM RUNOFF | IN. | 22.73 | 22.73 | |
| VELOCITY OF FLOW - V | FPS | 13.1 | 14.7 | |
| PEAK DISCHARGE RATE | CFS | 13,125 | 13,456 | |
| MAX. WATER SURFACE EL. | FEET | 291.7 | 292.2 | |
| <u>PRINCIPAL SPILLWAY</u> | | | | |
| RISER SIZE | FT. | 2 | 2 1/2 x 7 1/2 | |
| MAX. LOW STAGE FLOW | CFS | 106 | 113.9 | |
| ORIFICE SIZE | FT. | | | |
| MAX. HIGH STAGE FLOW | CFS | | | |
| PIPE SIZE | DIA. | | | |
| <u>CAPACITY EQUIVALENTS</u> | | | | |
| TOTAL SEDIMENT VOL. | IN. | 0.35 | 0.31 | |
| RETARDING STORAGE | IN. | 3.97 | 3.95 | |
| EM. SPILLWAY STORAGE TO TOP OF DAM | IN. | 4.51 | 5.05 | |
| <u>CLASS OF STRUCTURE</u> | - | C | C | |
| <u>CONSTRUCTION COSTS</u> | - | | | |
| <u>B-C RATIO</u> | - | | | |

REF:-
 SCS DESIGN
 FOLDER

1*****
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE: 79/12/10.
 TIME: 14.18.14.

RAILROAD CREEK DAM
 DER NO. 9-175
 INFLOW HYDROGRAPH

| NQ | HHR | HMIN | IDAY | JOB SPECIFICATION | | | | | IPLI | IPRT | NSTAN |
|-----|-----|------|-------|-------------------|-------|-------|------|------|------|------|-------|
| | | | | INR | IMIN | NETRC | IPRT | IPRT | | | |
| 200 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | -4 | 0 | | 0 |
| | | | JOPER | NUT | LROPT | TRACE | | | | | |
| | | | 5 | 0 | 0 | 0 | | | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NRTID= 1 LRTID= 1

RTIOS= 1.00

SUB-AREA KUNOFF COMPUTATION

INFLOW HYDROGRAPH

| ISTAD | ICONP | IECON | ITAPE | JPLT | JFRT | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| IN | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| INVDG | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|-------|------|-------|------|-------|-------|-------|-------|-------|-------|
| 1 | 1 | 3.39 | 0.00 | 3.39 | 0.00 | 0.000 | 0 | 1 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|------|-------|--------|--------|--------|--------|------|------|
| 0.00 | 23.50 | 113.00 | 123.00 | 132.00 | 143.00 | 0.00 | 0.00 |

INSFC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

| LROPT | STKR | MLKR | RTIOL | ERAIN | STIRS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|-------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .05 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA

TP= 2.24 CP= .81 NTA= 0

RECESSION DATA

SIRTO= -1.50 ORUSN= -.05 RTIOR= 2.00

| UNIT HYDROGRAPH 29 END-OF-PERIOD ORDINATES, LAG= 2.22 HOURS, CP= .80 VOL= 1.00 | | | | | | | | | |
|--|------|------|------|------|------|------|------|------|------|
| 34. | 124. | 241. | 367. | 493. | 615. | 717. | 780. | 803. | 791. |
| 744. | 646. | 518. | 406. | 318. | 249. | 195. | 153. | 119. | 94. |
| 73. | 57. | 45. | 35. | 28. | 22. | 17. | 13. | 10. | |

END-OF-PERIOD FLOW

| NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | NO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|-------|-------|--------|----------|----------|---------|-------------|-------|-------|--------|------|------|------|--------|
| 0 | | | | | | | | | | | | | |
| SUM | 26.88 | 24.47 | 2.42 | 2132/3. | | | | | | | | | |
| | | | (683.) | (621.) | (61.) | (6059.22) | | | | | | | |

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

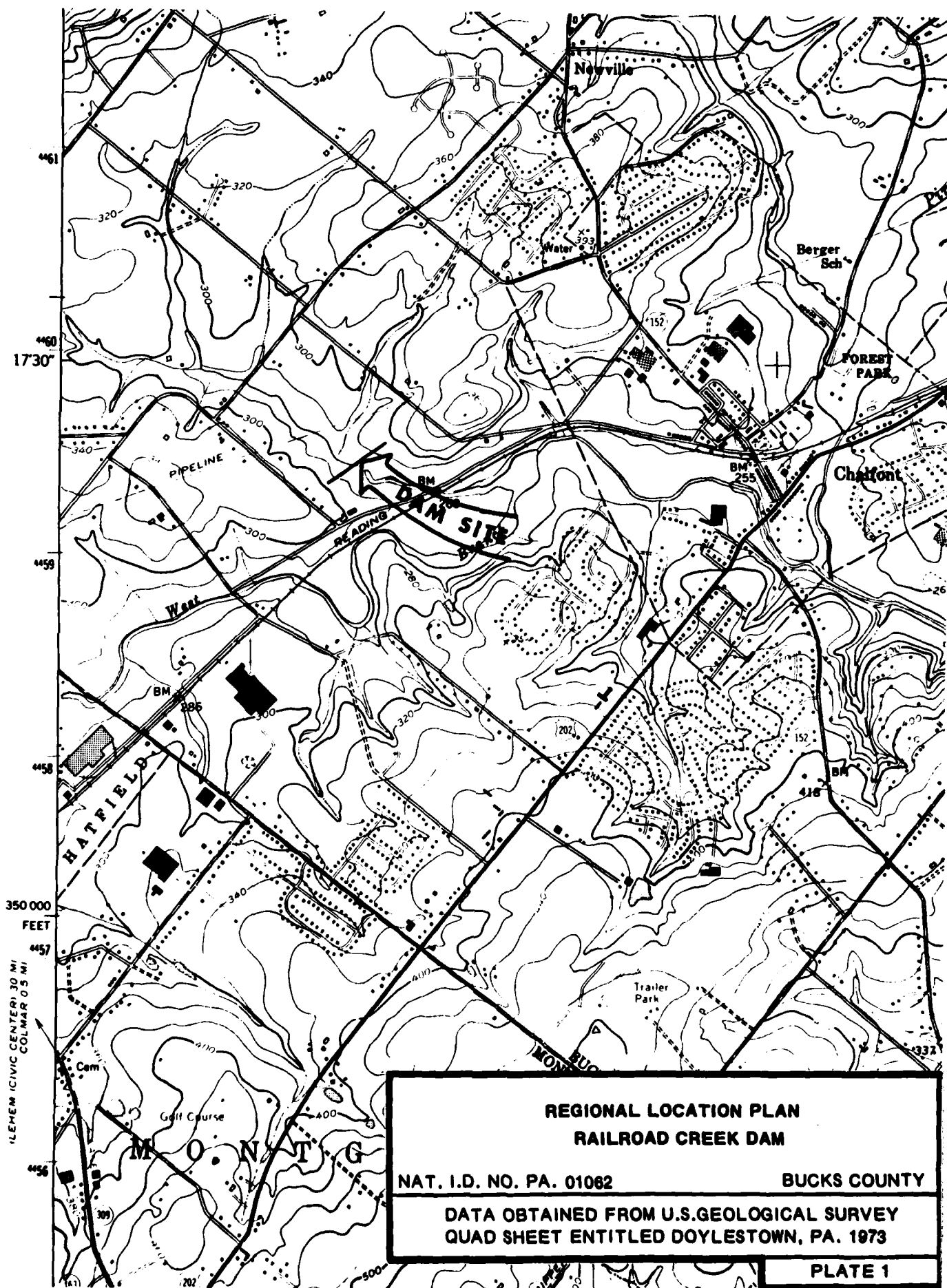
RATIOS APPLIED TO FLOWS

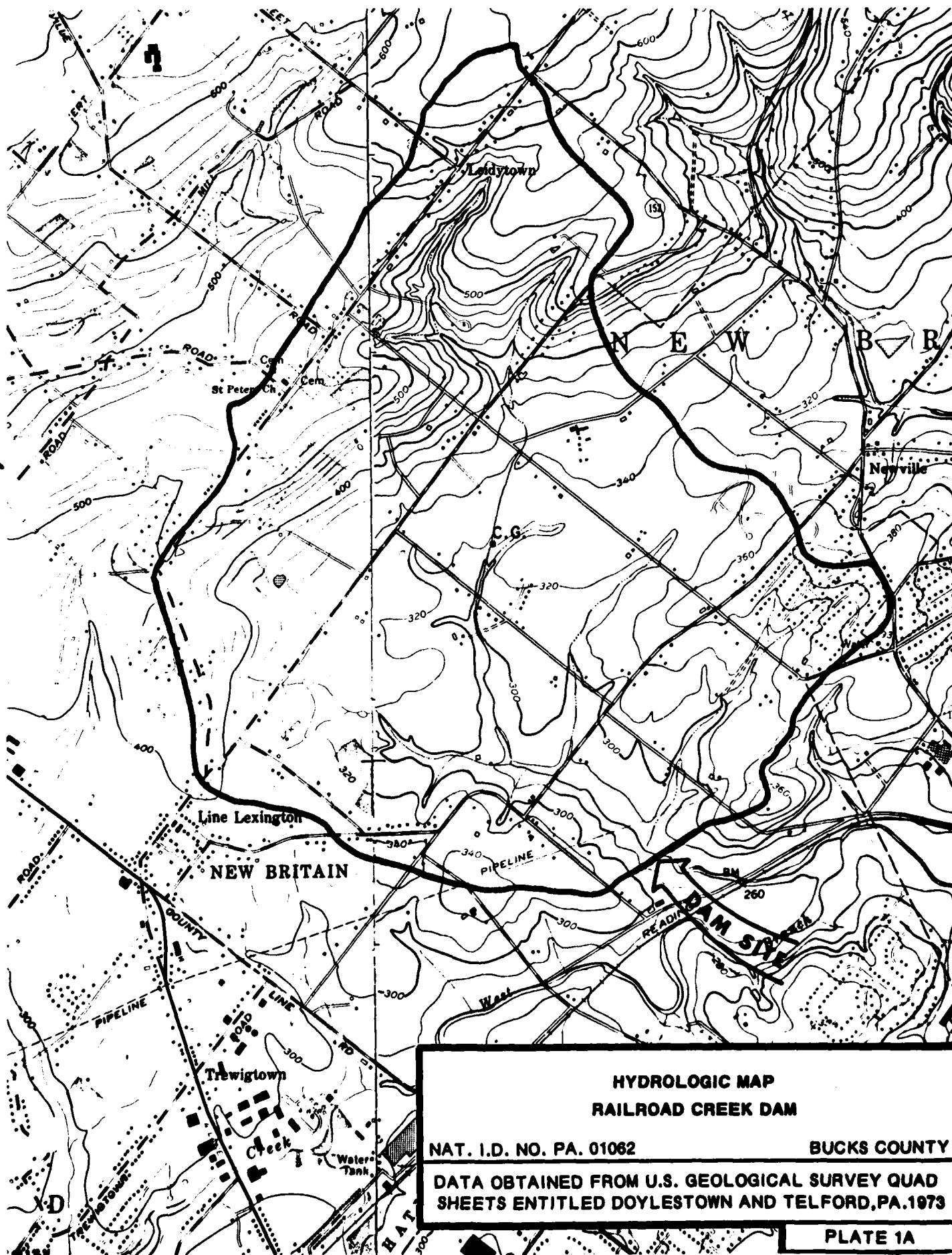
| OPERATION | STATION | AREA | PLAN RATIO | 1 |
|-----------|---------|------|------------|------|
| | | | | 1.00 |

| | | | | |
|---------------|----|-------|---|---------|
| HYDROGRAPH AT | IN | 3.39 | 1 | 10260. |
| | (| 8.78) | (| 290.52) |

APPENDIX

E


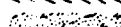


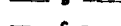
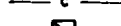



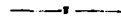

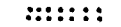

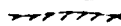




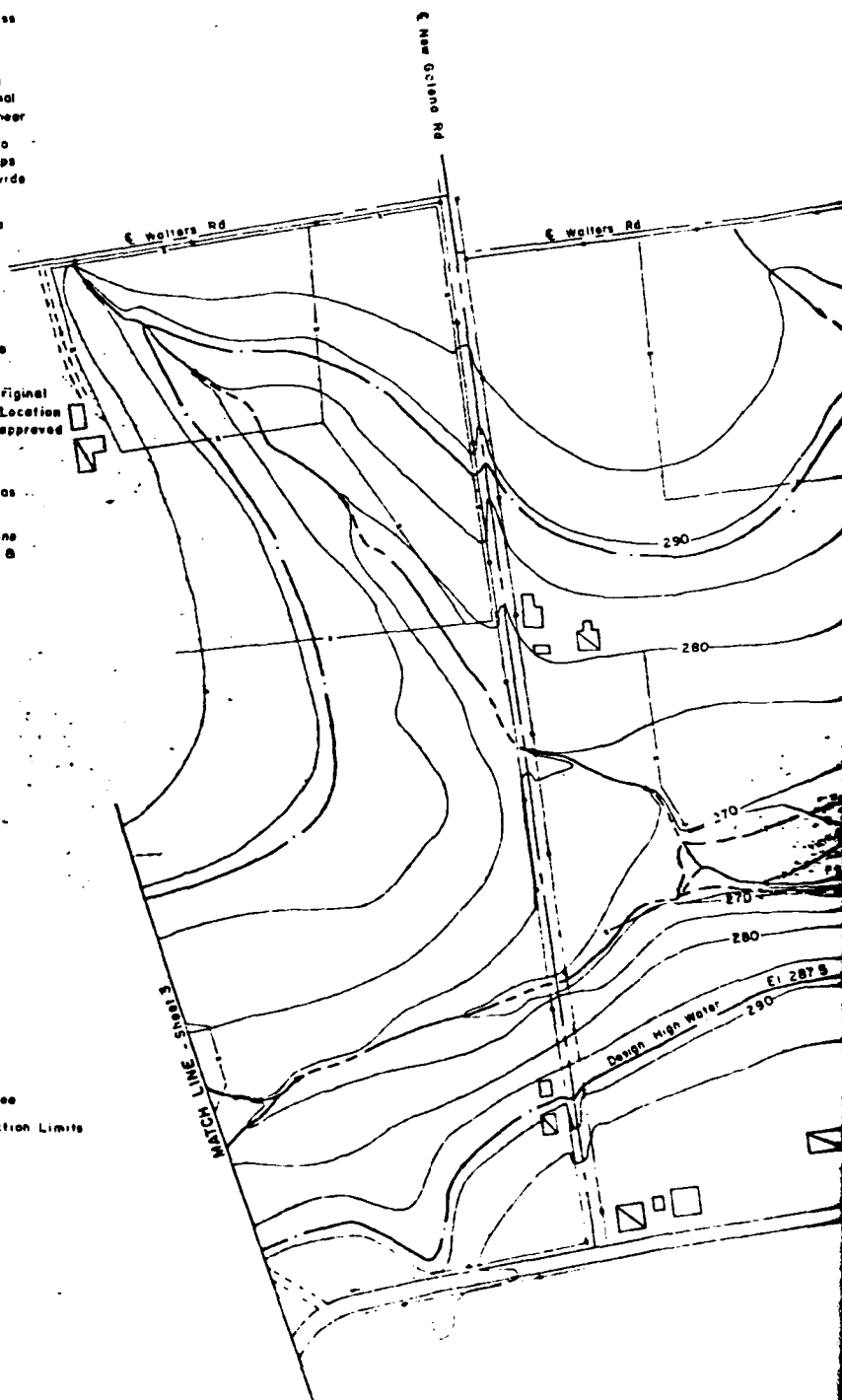


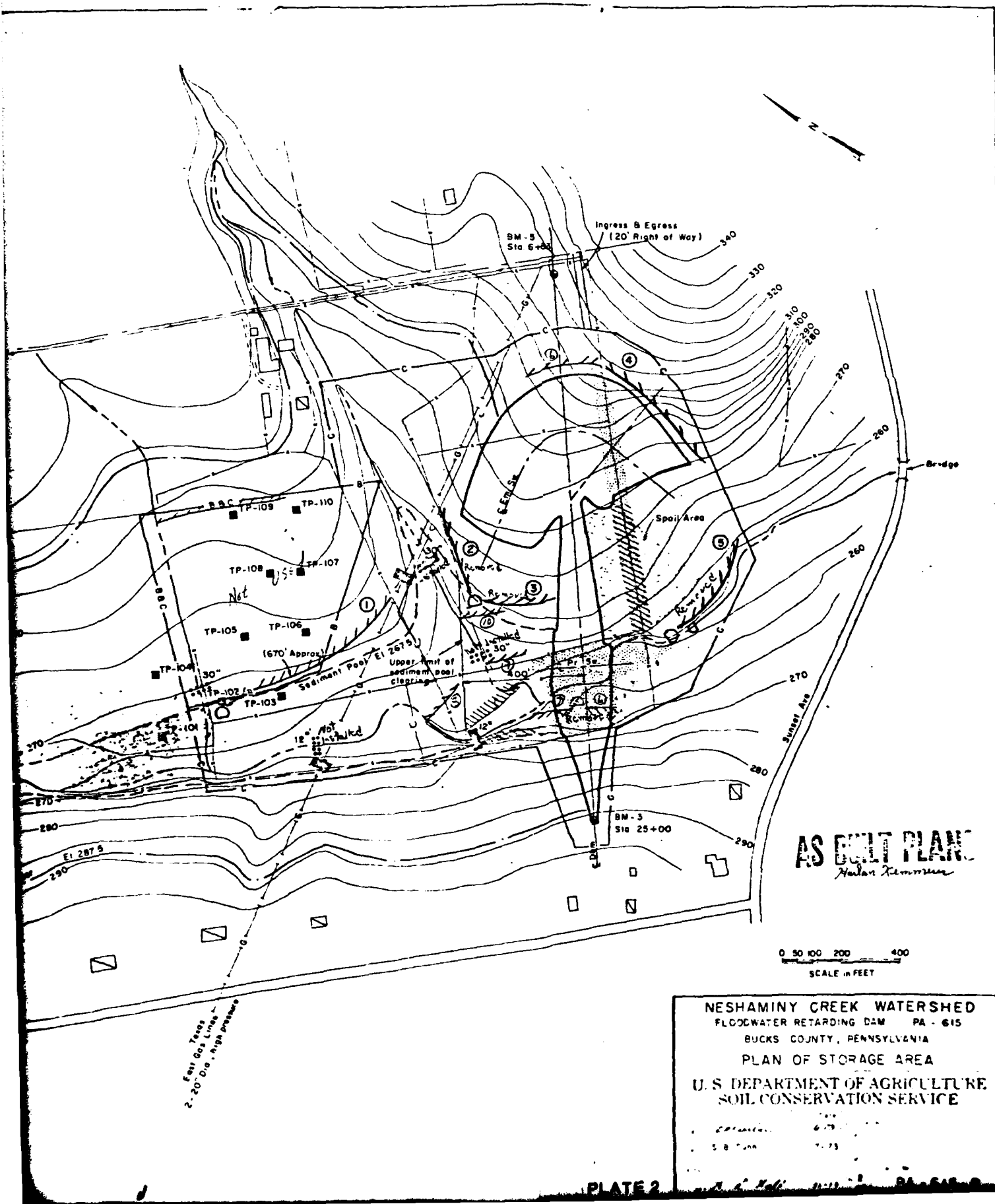
CONSTRUCTION NOTES

1. Borrow Area to be used only as directed by the Engineer.
2. Dam, Emergency Spillway and Channels to be Cleared and Grubbed.
3. Sediment Pool and Spoil Areas to be Class B Clearing as shown.
4. Location of Filter Dams, Stream Crossings, Clearing Areas and Clearing and Grubbing Areas are approximate. Final location will be determined by the Engineer.
5. Spoil Areas shall be left with at least two feet of cover over any brush, trees, stumps or boulders. They shall be shaped to provide positive drainage.
6. Slopes of Borrow Area and Spoil Area shall be no steeper than 3 to 1.
7. Borrow Area may be utilized as Spoil Area after required fill has been removed.
8. All existing fences within Construction Limits shall be removed as directed by the Engineer.
9. A minimum of 5' of Zone II fill above original ground over all gas pipeline crossings. Location of the gas pipeline crossing shall be approved by the Engineer and Texas Eastern.
10. No excavation will be allowed within 25' on either side of the centerline of any gas pipeline.
11. Sediment pool to be cleared between a line 400' upstream from E. dam to clearing & grubbing limit at dam.

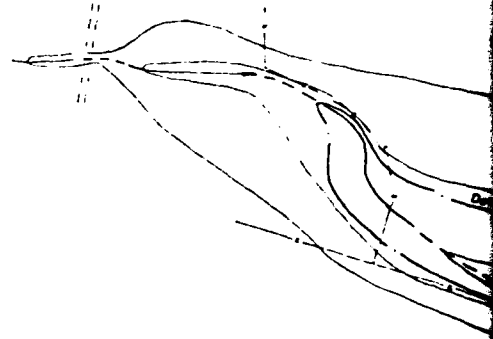
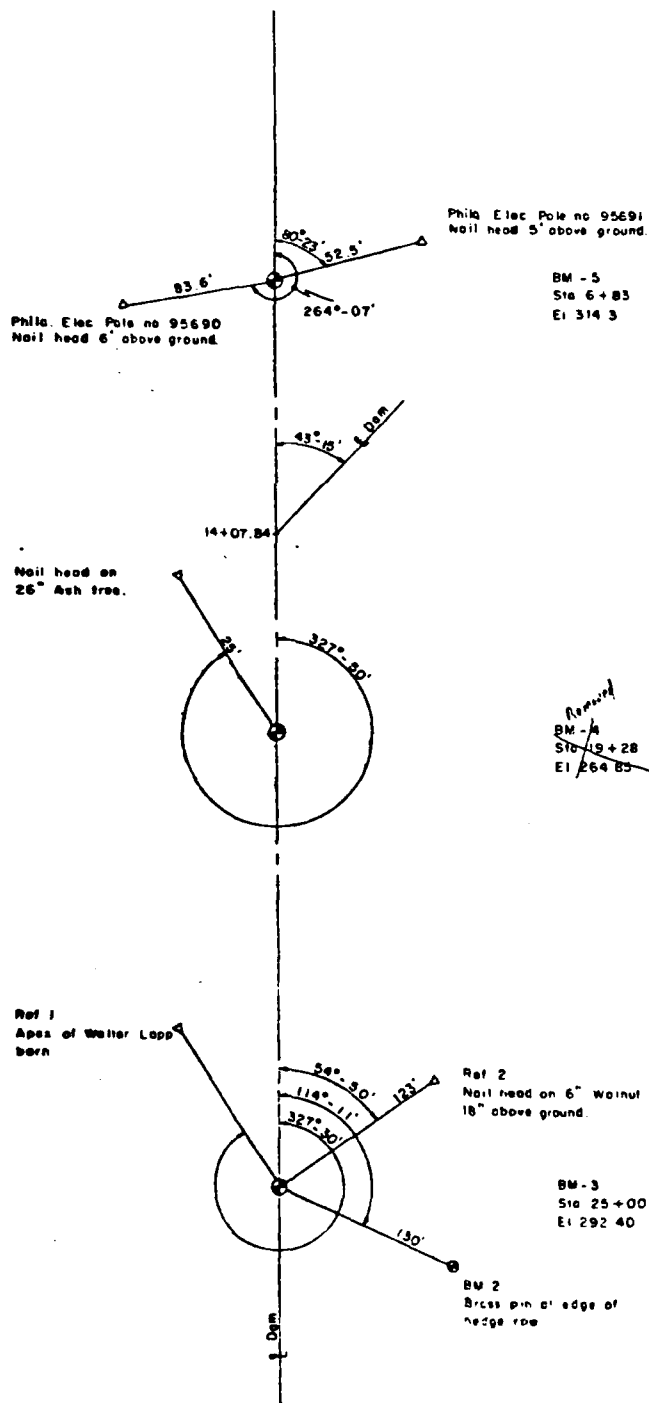
LEGEND

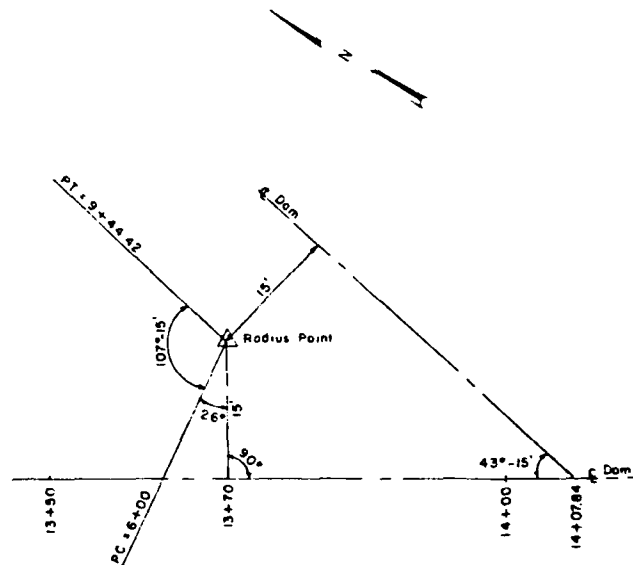
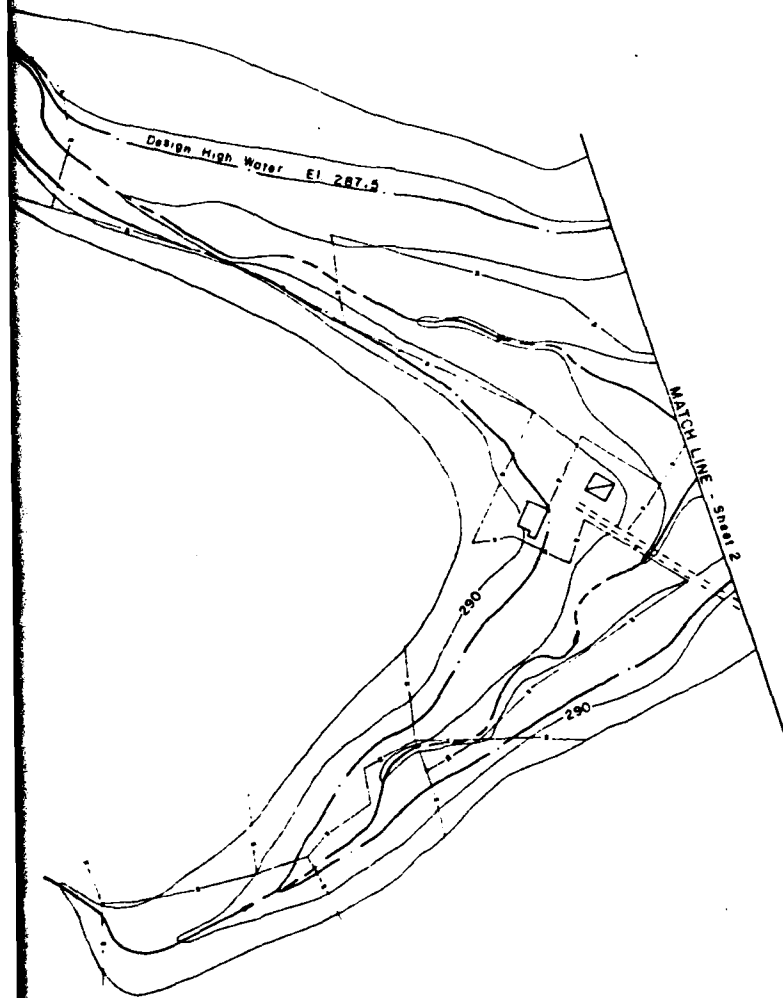
| | |
|---|-----------------------------------|
|  | Clearing Area |
|  | Clearing & Grubbing Area |
|  | Borrow Area & Construction Limits |
|  | Borrow Area |
|  | Construction Limits |
|  | House |
|  | Other Building |
|  | Elec. or Tel. Line |
|  | Fence |
|  | Test Pit |
|  | Stream Crossing |
|  | Spoil Area |
|  | Diversion |
|  | Filter Dam |
|  | Pipeline Crossing (Data sheet 28) |
|  | Gas Pipe Line (High Pressure) |





E DAM LAYOUT
NOT TO SCALE





EM SW RADIUS POINT LOCATION

0 2 5 10 20
SCALE in FEET

AS BUILT PLANS
John Hammer

0 50 100 200 400
SCALE in FEET

NESHAMINY CREEK WATERSHED
FLOODWATER RETARDING DAM PA - 615
BUCKS COUNTY, PENNSYLVANIA

PLAN OF STORAGE AREA

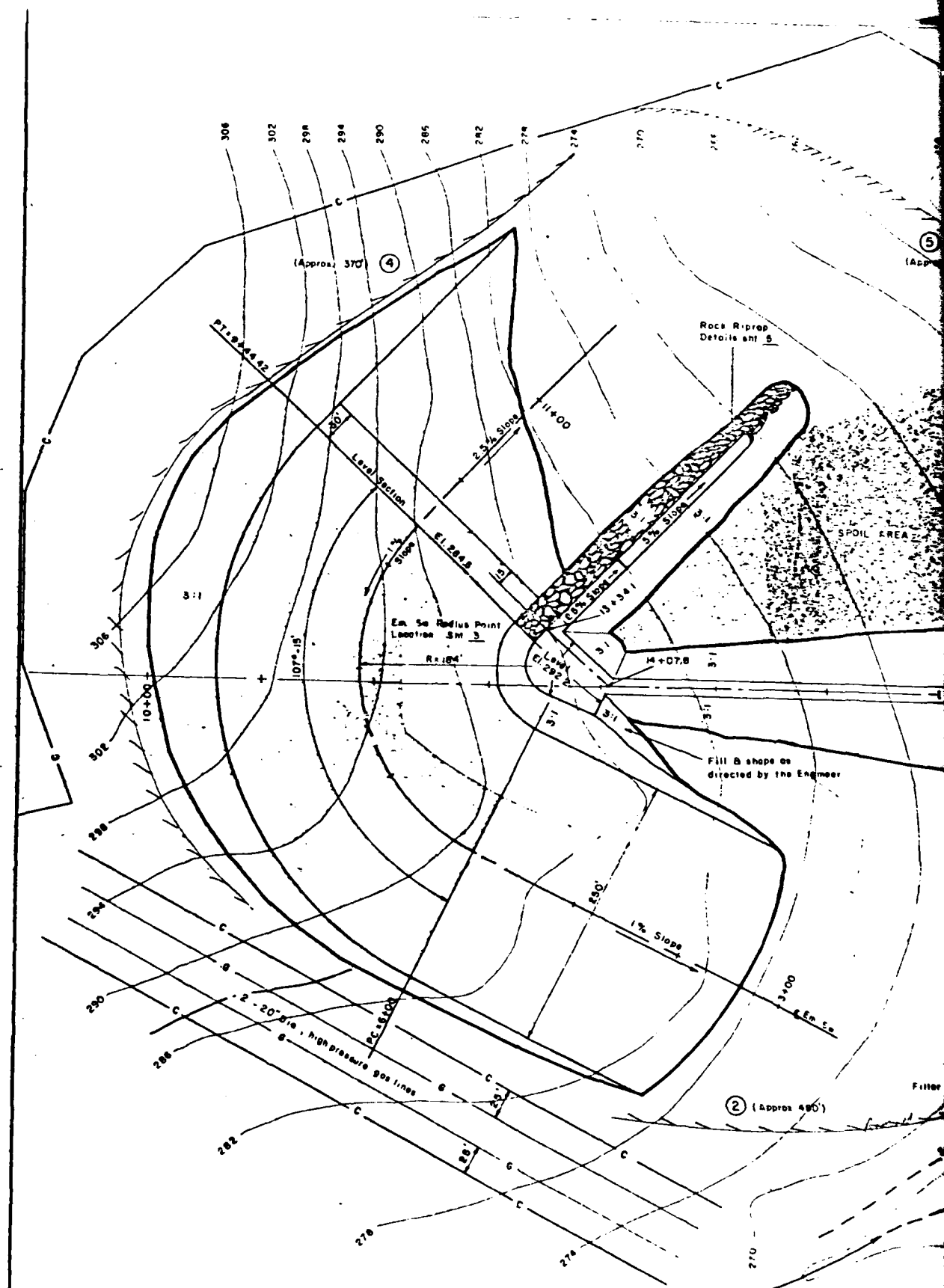
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

S. B. Dunn 7-73

PLATE 3

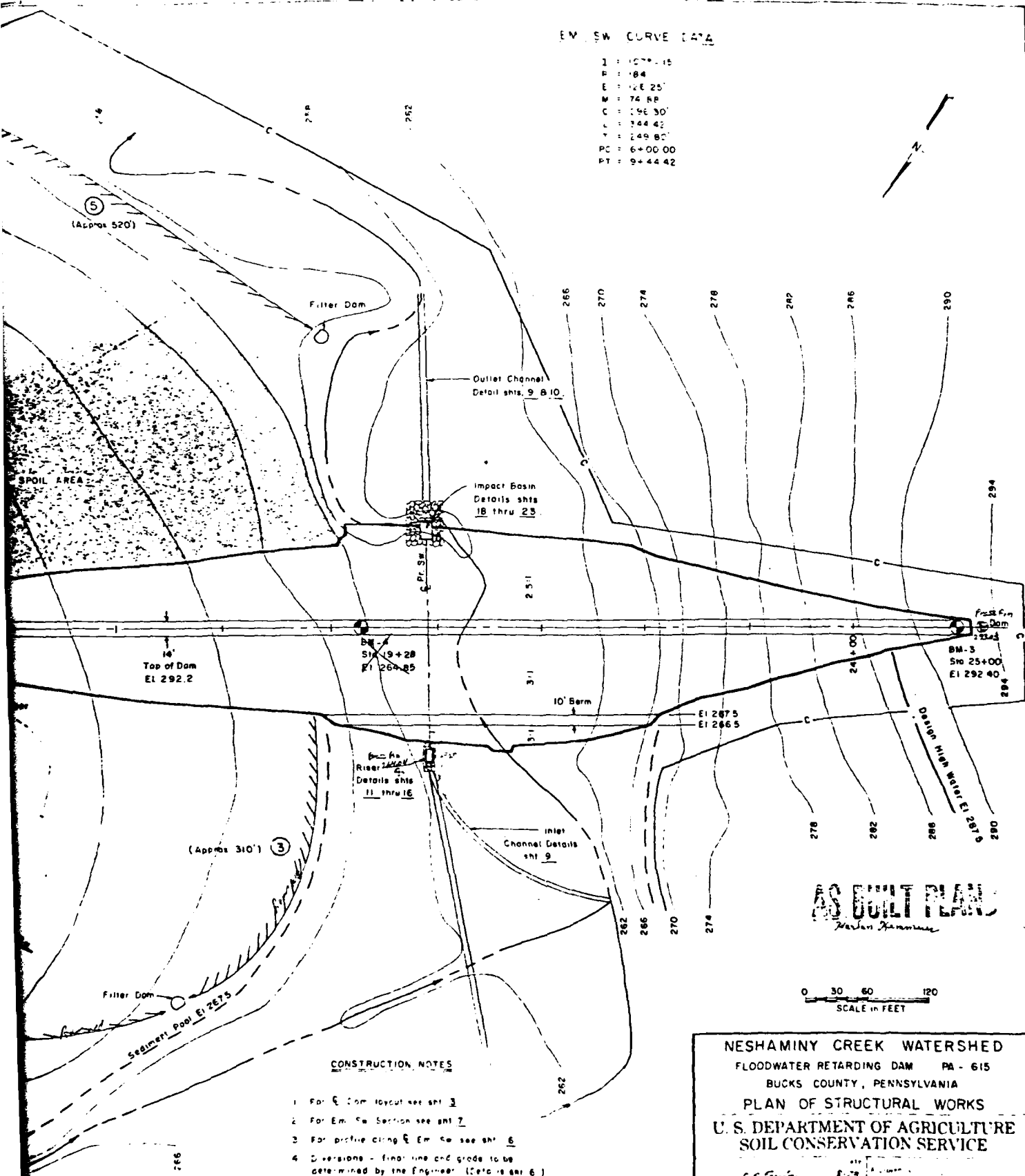
PA - 615 - P

2



EM SW CURVE DATA

1 = 1077+15
 E = 12E 25'
 M = 74.88
 C = 196.30'
 L = 344.43'
 T = 249.80'
 PC = 6+00.00
 PT = 9+44.42



CONSTRUCTION NOTES

1. For E. Dam layout see shi 3
2. For Em. Sw Section see shi 7
3. For profile along E. Em. Sw see shi 6
4. Elevations - final line and grade to be determined by the Engineer (Data is shi 6.)

NESHAMINY CREEK WATERSHED
 FLOODWATER RETARDING DAM PA - 615
 BUCKS COUNTY, PENNSYLVANIA
 PLAN OF STRUCTURAL WORKS
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

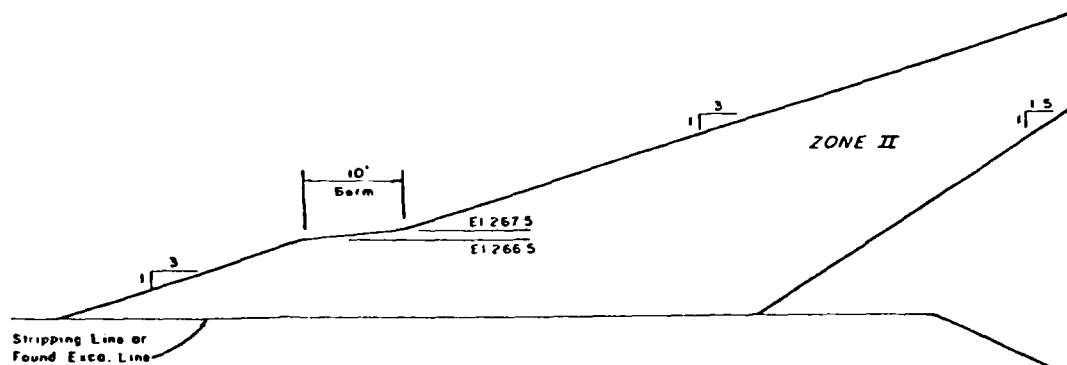
S. B. Dunn

10-75

PLATE 4

PA-615-P

2

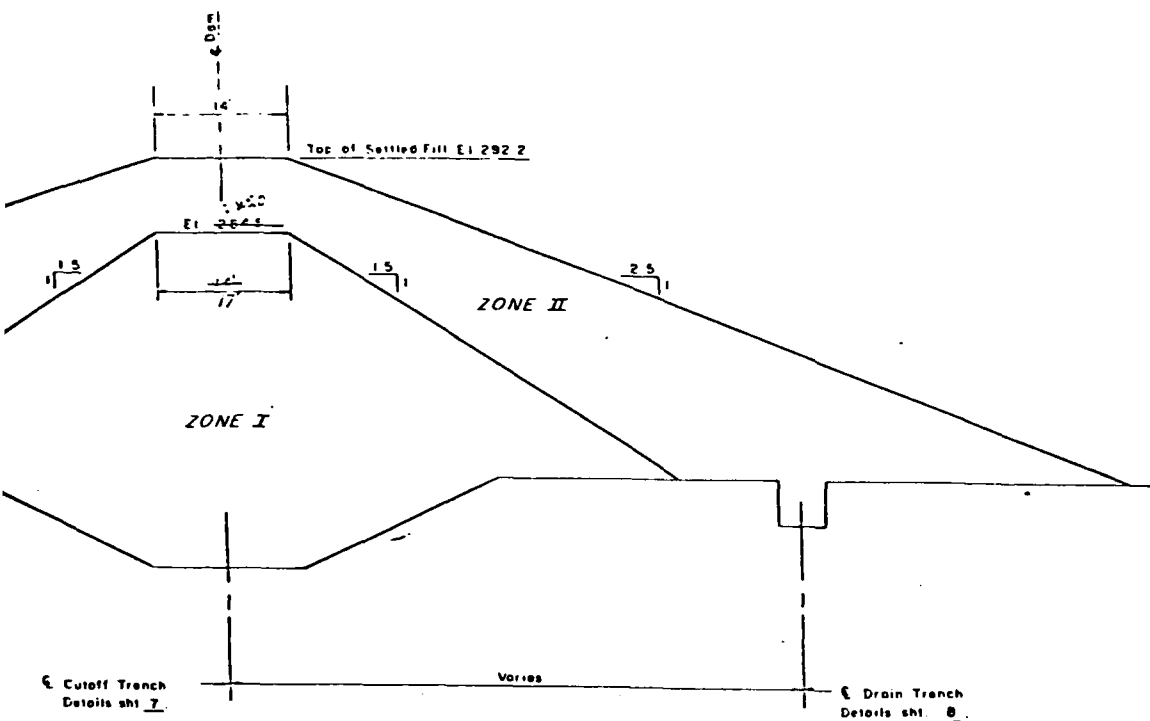


C. Cut-off
Detail

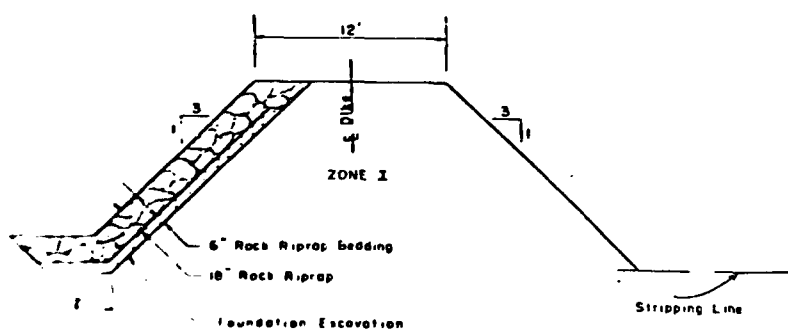
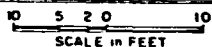
| ZONE | MATERIAL | MAX. ROCK SIZE | MAX. LIFT | REQ'D. WATER CONTENT | COMPACTION | |
|------|---|----------------|-----------|---|------------|--|
| | | | | | CLASS | DEFINITION |
| I | Material as represented by TP-108.1, depth 0.6' to 4', CL; by TP-216.1, depth 1.7' to 6', CL; by TP-217.1, depth 1' to 3', ML | 6" | 9" | Optimum to + 3 % | A | 95% max density by ASTM, D-698, Method A. |
| II | Material as represented by TP-108.2, depth 4' to 6', GM; by TP-217.2 B.3, depth 3' to 12.8', GM-GP. | 12" | 18" | Optimum to + 3 % (minus no. 4 material) | C | Min 6 passes with 450psi tamping roller per lift |

Bottom Em. Se

- 1 Max. permissible lift thickness before compaction
- 2 Water content of fill matrix at time of compaction. Variation from water content shown may be approved by the Engineer.
- 3 For typical compaction curves see shts. 36 & 37.
- 4 For hand compacted backfill the maximum rock size shall not exceed 3" and lift thickness shall not exceed 4".



TYPICAL SECTION OF DAM



ROCK RIPRAP SECTION OF DIKE
NOT TO SCALE

AS BUILT PLAN
Nashaminy Creek Watershed

CONSTRUCTION NOTES

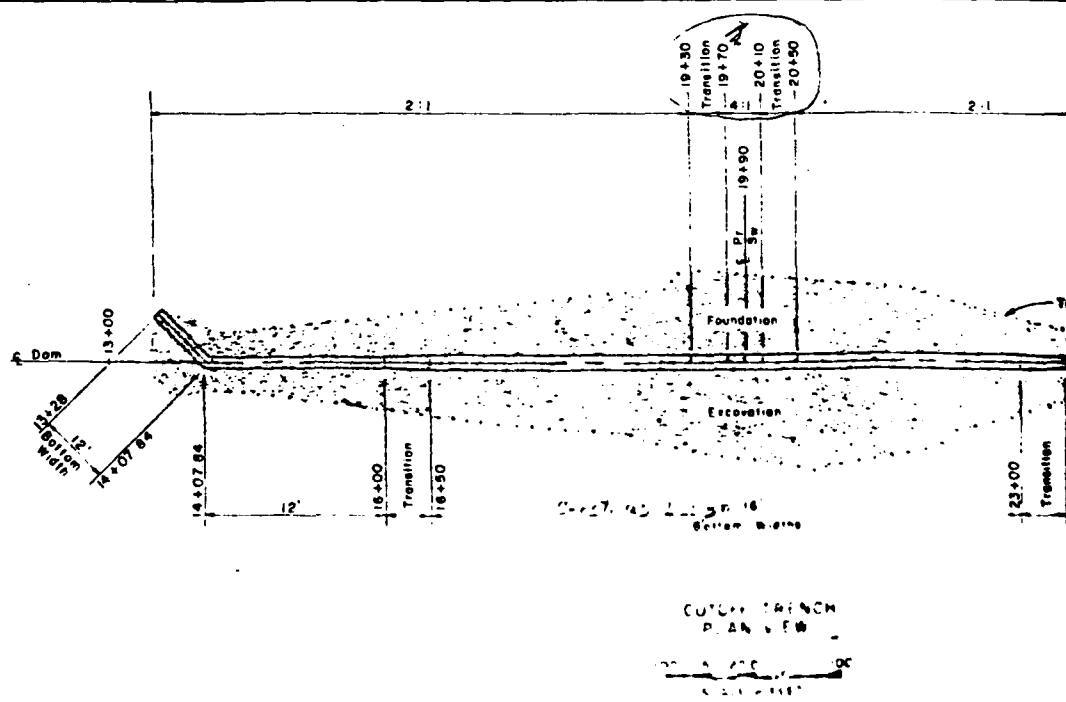
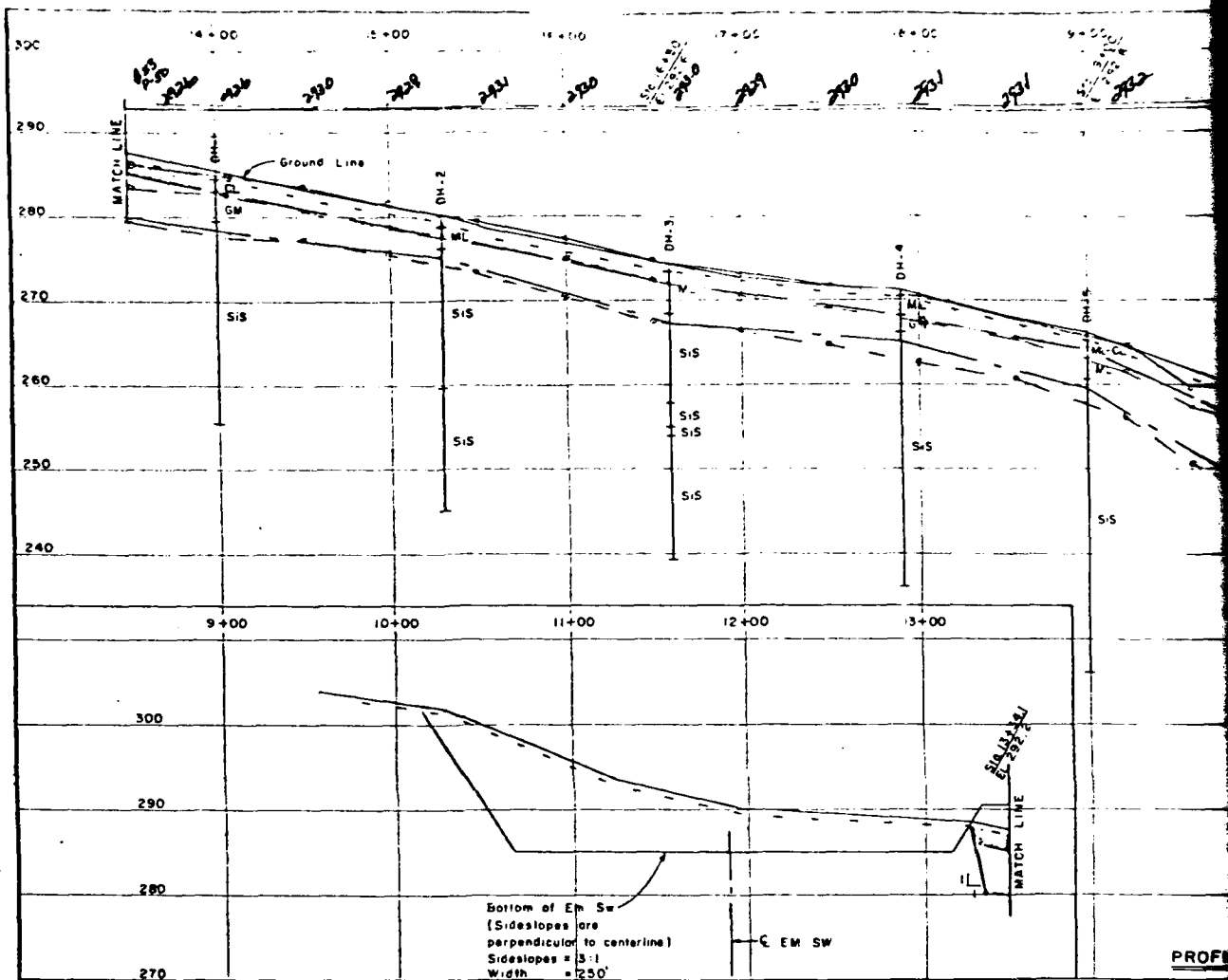
- 1 Constructed slopes are
2.93:1 Upstream
2.46:1 Downstream
- 2 For constructed fill elevations
see shd. 7

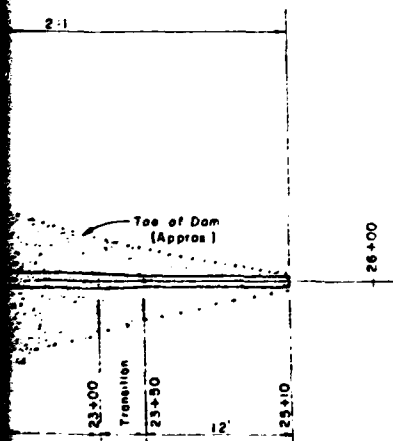
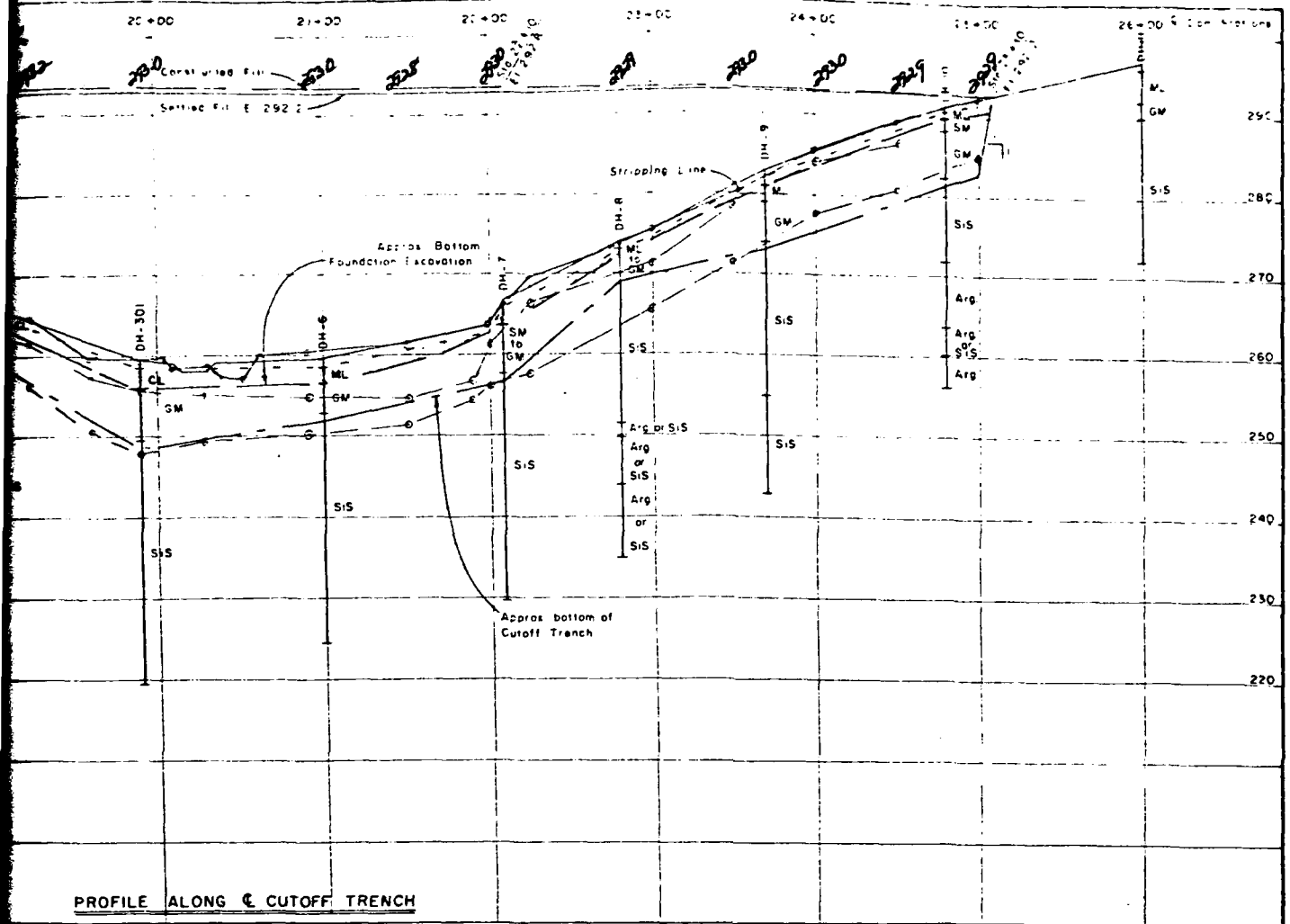
NESHAMINY CREEK WATERSHED
FLOODWATER RETARDING DAM PA - 615
BUCKS COUNTY, PENNSYLVANIA

FILL PLACEMENT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PA - 615 - P





CONSTRUCTION NOTES

1. Dam - Cutoff Trench
2. For logs of test holes see sheets 28 thru 35.

AS BUILT PLANS
James H. Hume

NESHAMINY CREEK WATERSHED
 FLOODWATER RETARDING DAM PA - 615
 BUCKS COUNTY, PENNSYLVANIA

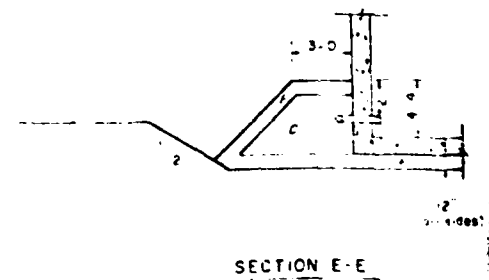
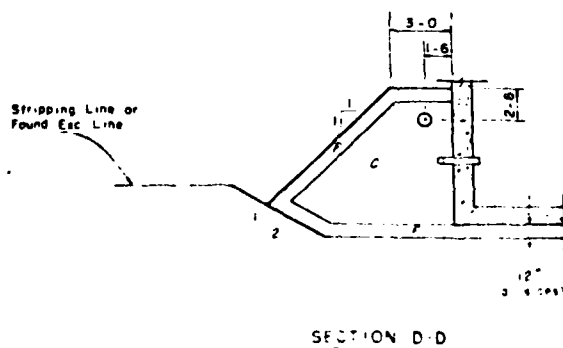
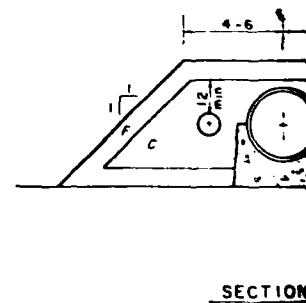
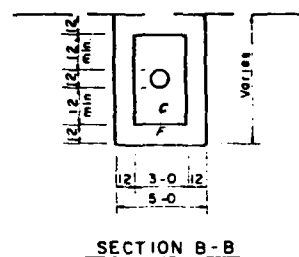
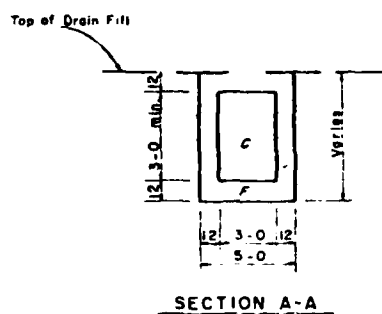
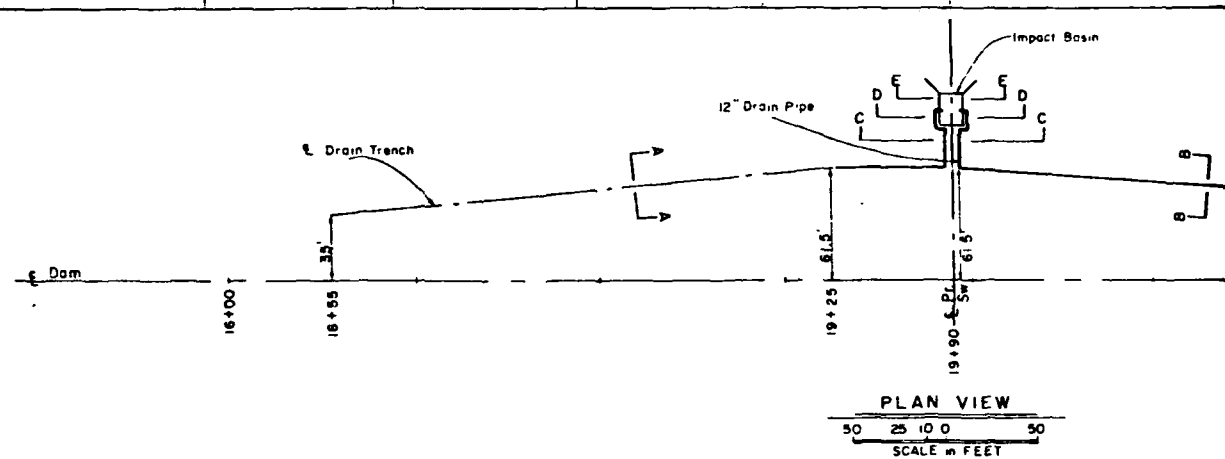
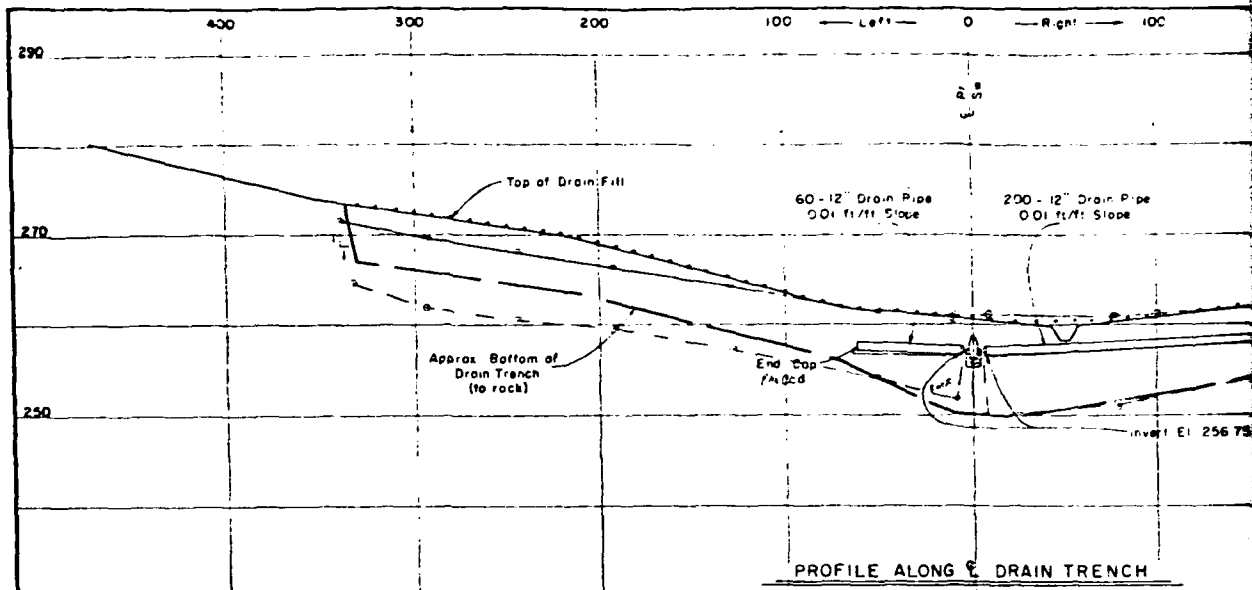
PROFILE ALONG DAM
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

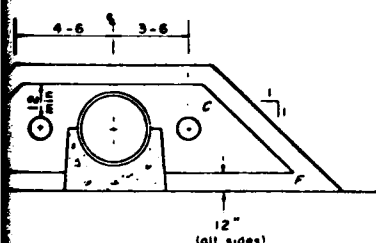
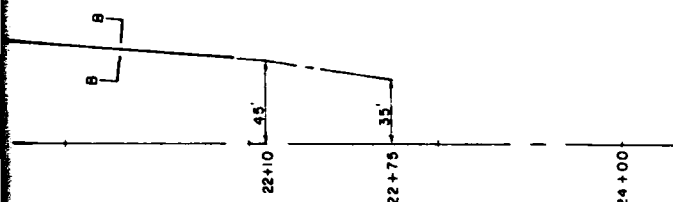
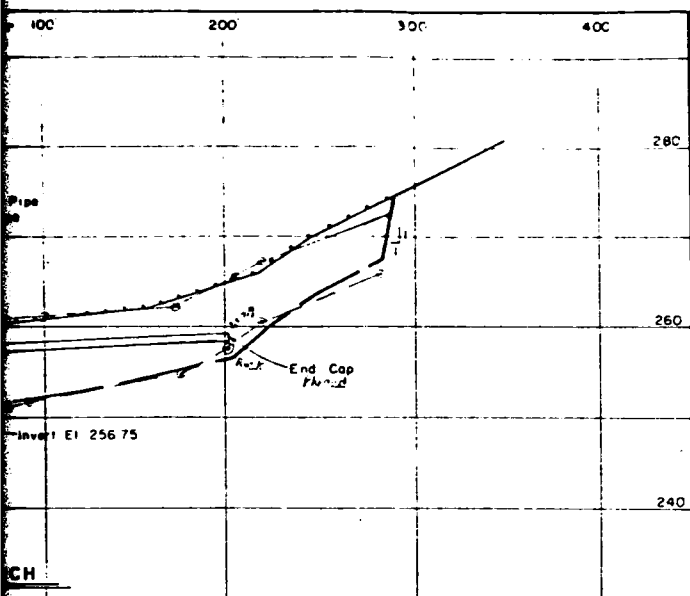
S. B. Dunn 9-73

PLATE 6

PA-615-P

2





SECTION C-C

CONSTRUCTION NOTE

1. All 12" drain pipe will be Class I or II, Shape 1, Coating A, 16 Gauge, Perforated (Spec 551).
2. See spec for 12" CMP details, including embedment basin.

Spec Model T.D. 12.5 G
Rev. 11/11/88, 12

GRADATION LIMITS

FINE DRAIN FILL (F)

| SIEVE NO | % PASSING BASED ON DRY WEIGHT |
|----------|-------------------------------|
| 3/8" | 100 |
| no. 4 | 57.21 90 - 100 |
| no. 8 | 27.79 70 - 100 |
| no. 16 | 28.79 50 - 85 |
| no. 30 | 57.44 30 - 65 |
| no. 50 | 16.17 10 - 30 |
| no. 100 | 2.60 1 - 8 |
| no. 200 | 1 - 3 |

material west side of road

COARSE DRAIN FILL (C)

| SIEVE NO | % PASSING BASED ON DRY WEIGHT |
|----------|-------------------------------|
| 1-1/2" | 100 |
| 1" | 99.5 90 - 100 |
| 3/4" | 26.71 25 - 60 |
| no. 4 | 0.64 0 - 10 |
| no. 8 | 0.20 0 - 5 |
| no. 200 | 1 - 3 |

Tested on Site 5-23-77 Fine & Coarse Drain Fill by Rammer

11-11-88 Rev. 12

DRAIN PIPE QUANTITY SUMMARY

- 316' - 12" Drain Pipe
- 2 - 1'x1' Elbows, 90°
- 2 - 1'x2' Elbows, 90°
- 2 - 1'x2'-4" Elbows, 90°
- 2 - 1'-6" x 3' Elbows, 90°
- 2 - End Caps
- 2 - Small Animal Guards (shl 26)

341'-8" - Total

AS BUILT PLANS
Neshaminy Creek Watershed

NOT TO SCALE

NESHAMINY CREEK WATERSHED
FLOODWATER RETARDING DAM PA - 615
BUCKS COUNTY, PENNSYLVANIA

DRAINAGE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Inlet Channel
(Grade for drainage)
Line and shape to be
determined by the
Engineer

Shape as directed
by the Engineer

Riser
Details shts 11 thru 16

Transition

310 2 + 83.50

EI 266.5

EI 267.5

EI 292.2

Top of
Com

6' Dem

CONSTRUCTION NOTES

1. Outlet end of one standard 30" section to be finished so that no metal is exposed and shall be installed at the impact basin.
2. Pipe layout data to be furnished by the Engineer.
3. Riprap bedding shall meet gradation limits for fine drain fill. (sht. 8)
4. For excavation details, see sht 10.

PLAN VIEW

20 10 0
SCALE in FEET

18" Rock Riprap & 6"
bedding cover required
around Pipe

7. Anti-Seep Collars, Details sht 17

Riser

Bottom of Inlet Channel

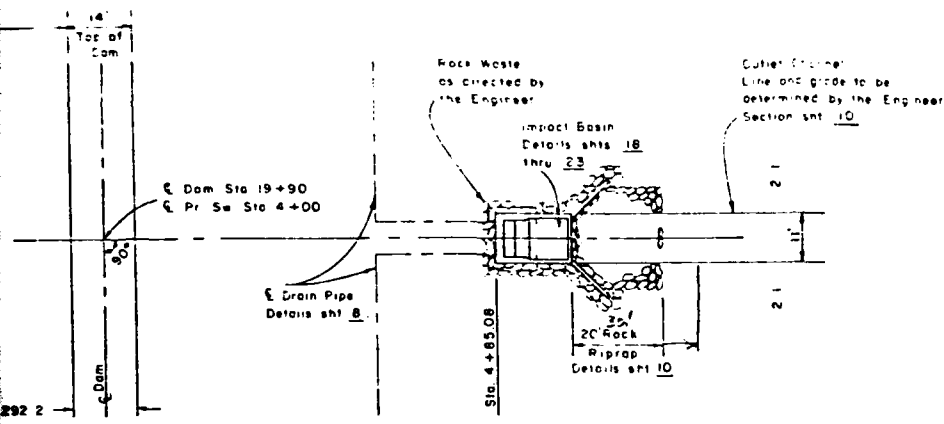
Conc Grade, D

116.42'

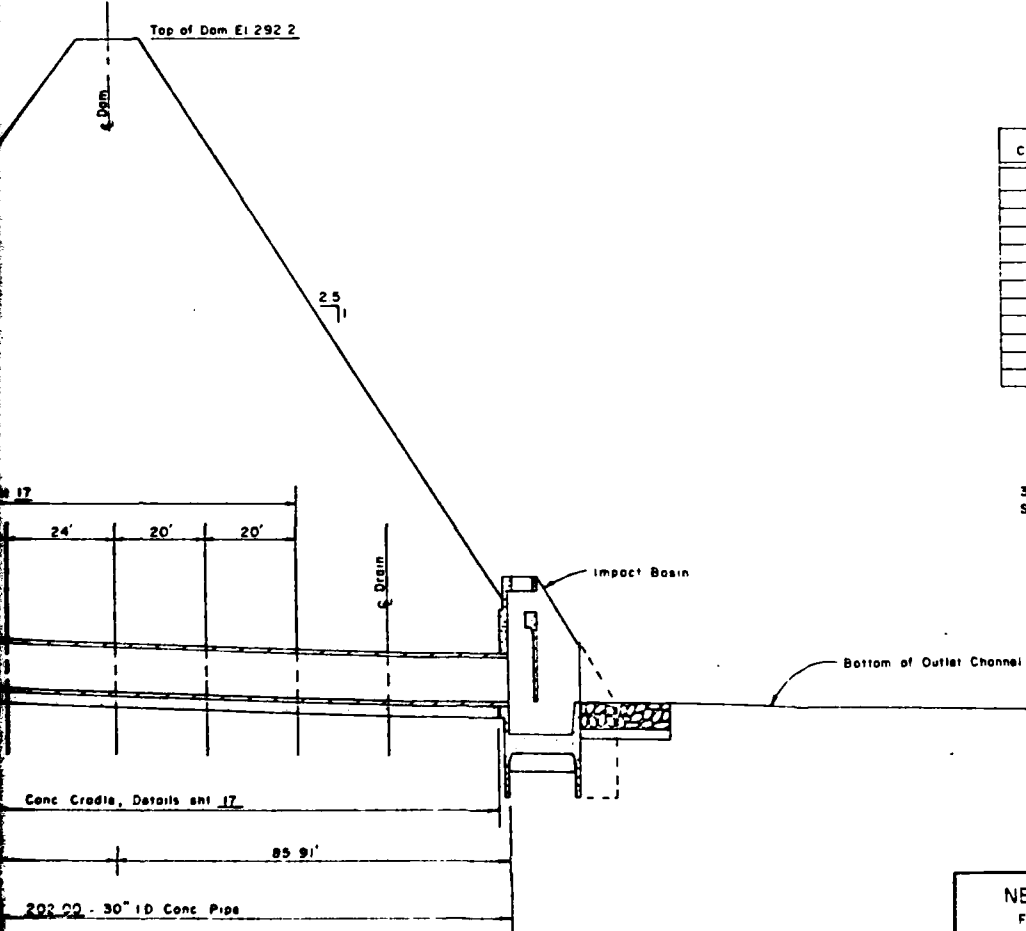
202.02 - 30" L

PROFILE ALONG C.P.

20 10 0
SCALE in FEET



PLAN VIEW
20 10 0 20
SCALE in FEET



ALONG & PRINCIPAL SPILLWAY
10 4 0 5 3 1 0
SCALE in FEET

AS BUILT
30" ID PIPE JOINT DATA

| JOINT | DIST FROM RISER WALL | INVERT | ELEV |
|-------|----------------------|--------|------|
| 1 | 24 | 257.31 | |
| II | 44 | 257.15 | |
| III | 64 | 256.95 | |
| IV | 84 | 256.76 | |
| V | 104 | 256.56 | |
| VI | 124 | 256.40 | |
| VII | 144 | 256.28 | |
| 18 | 164 | 256.14 | |
| 19 | 184 | 256.01 | |
| 20 | 204 | 255.83 | |

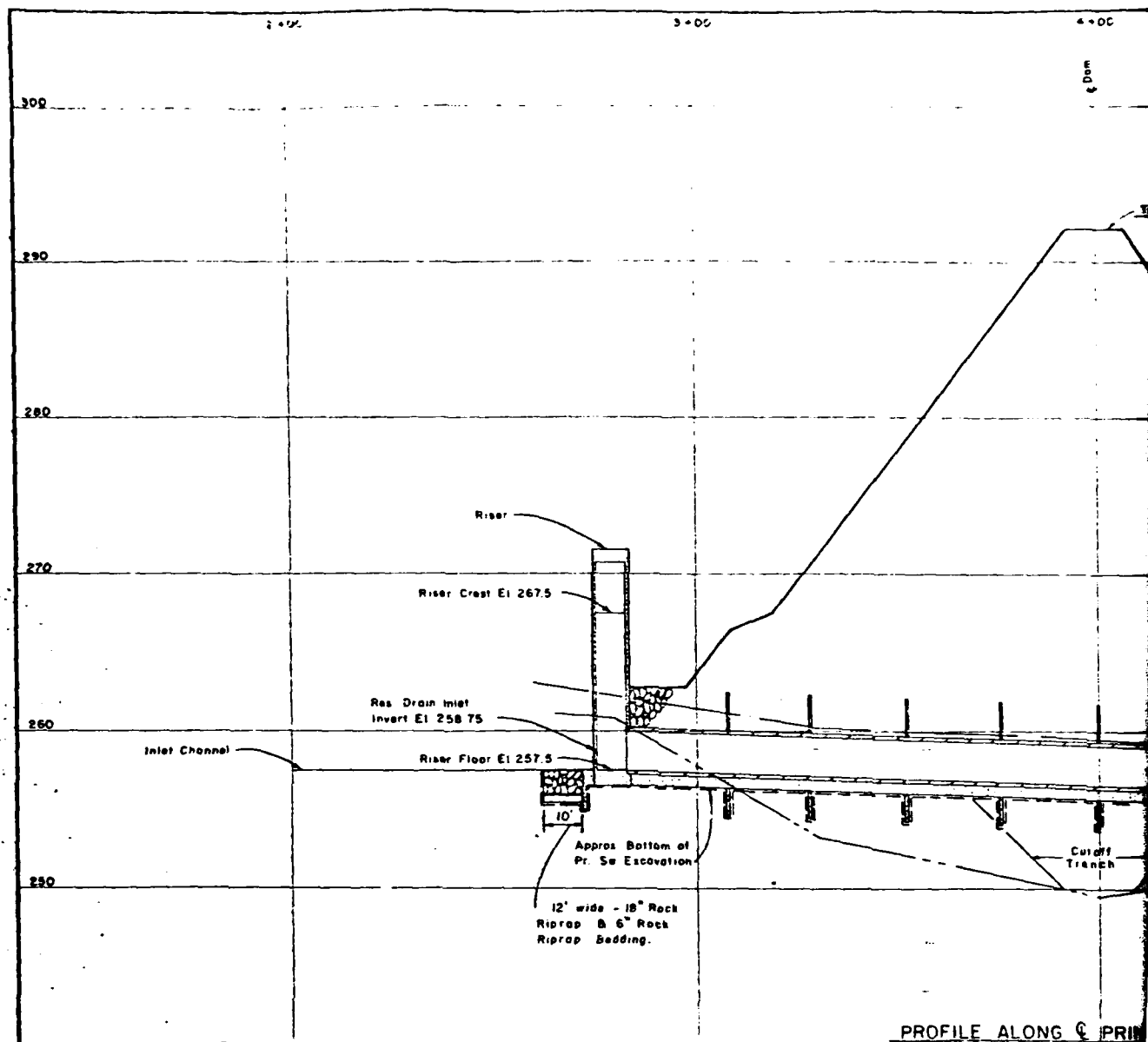
AS BUILT
COLLAR DATA FOR 30" ID PIPE

| COLLAR | DIST FROM RISER WALL | INVERT ELEV |
|-------------------|----------------------|-------------|
| I | 24 | 257.31 |
| II | 44 | 257.15 |
| III | 64 | 256.95 |
| IV | 84 | 256.76 |
| V | 104 | 256.56 |
| VI | 124 | 256.40 |
| VII | 144 | 256.28 |
| Const as Designed | | |

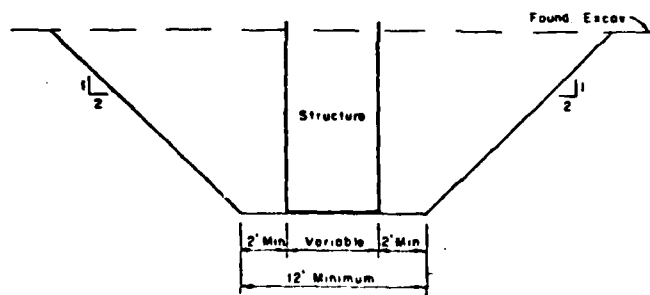
30" I.D. Reinforced Concrete Pressure Pipe
Steel Cylinder Type, Spec 541 (AWWA C-301 & C-300)
202' - Straight Sections
1 - Spigot Wall Fitting (for 10" wall)
202.00' - Total

AS BUILT PLANS
Nashua Kimmey

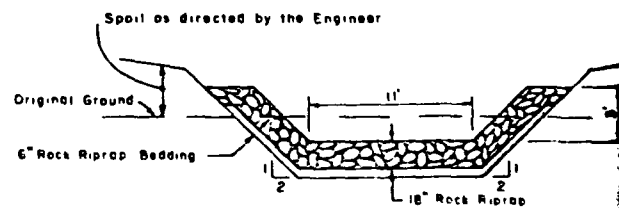
NESHAMINY CREEK WATERSHED
FLOODWATER RETARDING DAM PA - 615
BUCKS COUNTY, PENNSYLVANIA
PRINCIPAL SPILLWAY
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
S. B. Dunn 10-73
PA-615-P



PROFILE ALONG C. PRIN

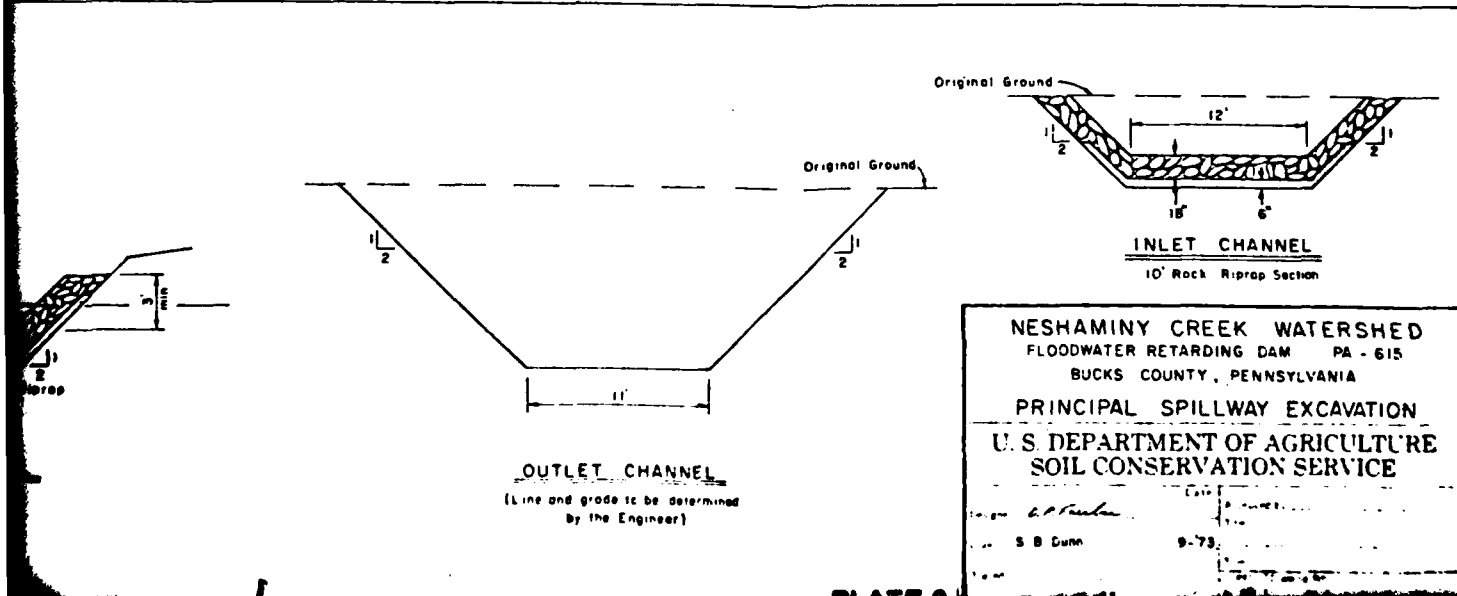
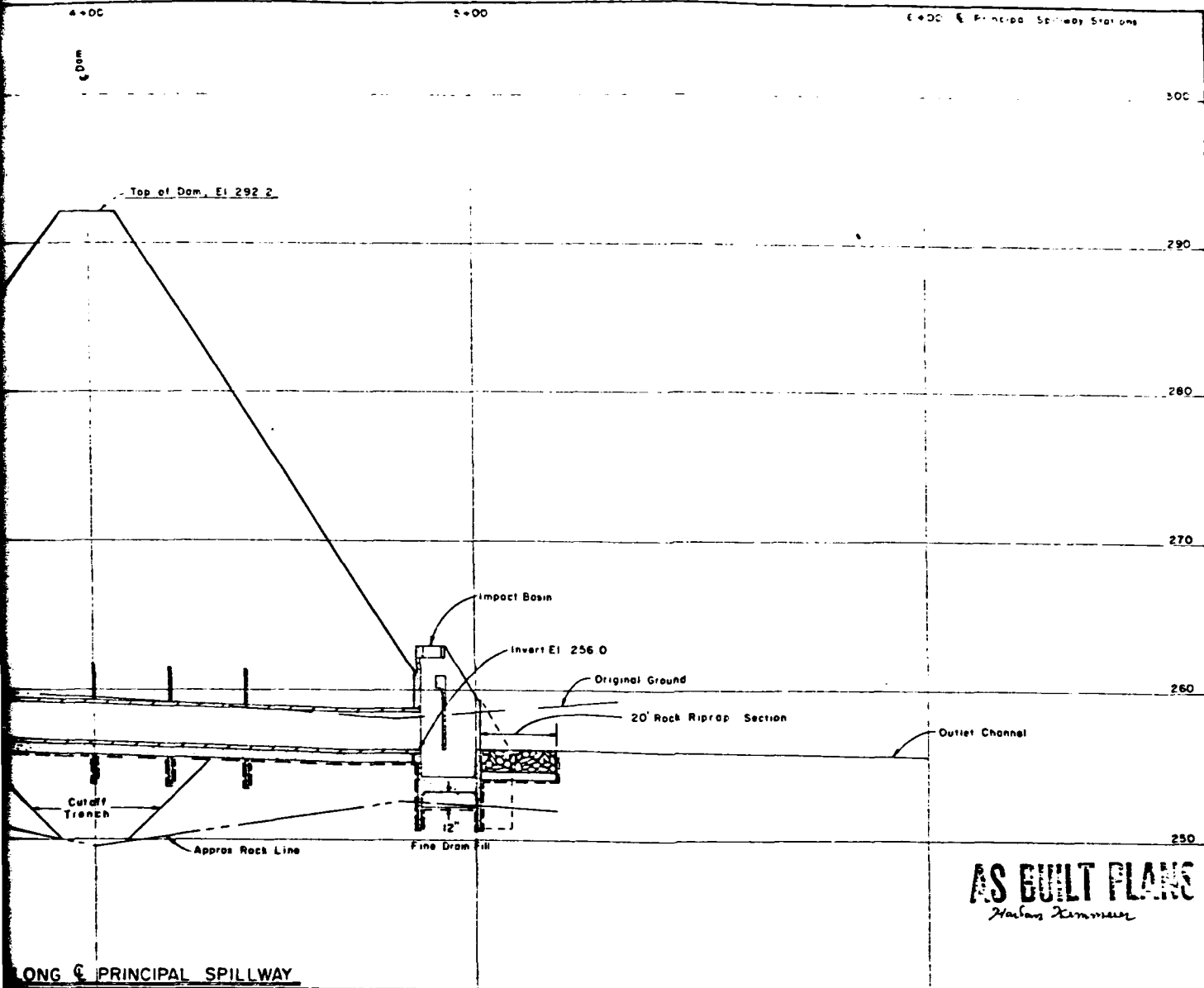


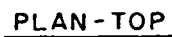
PRINCIPAL SPILLWAY



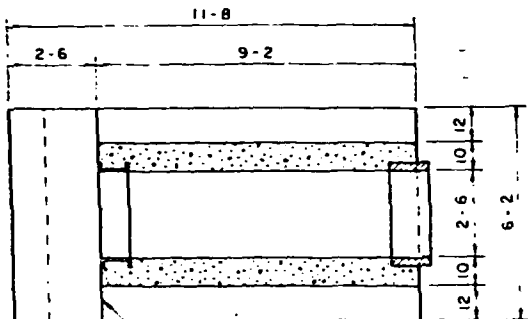
OUTLET CHANNEL
20' Rock Riprap Section

4+00 5+00 6+00 Principal Spillway Stations

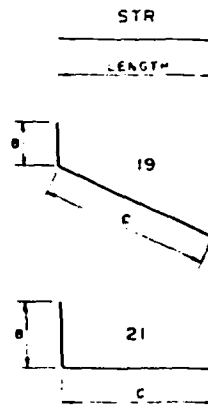




E



SECTION B-B



BAR TYPES

| RISER STEEL SCHEDULE | | | | | | | | | |
|----------------------|------|----------|--------|------|-----|-----|--------------|--|--|
| MARK | SIZE | QUANTITY | LENGTH | TYPE | B | C | TOTAL LENGTH | | |
| B 1 | 5 | 30 | 5-9 | STR | | | 172-6 | | |
| B 2 | 5 | 2 | 2-0 | STR | | | 4-0 | | |
| B 3 | 7 | 13 | 8-9 | STR | | | 113-6 | | |
| B 4 | 5 | 1 | 8-0 | STR | | | 8-0 | | |
| B 5 | 5 | 14 | 6-9 | 21 | 5-9 | 1-0 | 94-6 | | |
| B 6 | 5 | 3 | 2-3 | 21 | 1-3 | 1-0 | 6-9 | | |
| B 7 | 5 | 3 | 2-9 | 21 | 1-9 | 1-0 | 8-3 | | |
| B 8 | 7 | 18 | 9-0 | 21 | 6-0 | 3-0 | 162-0 | | |
| B 9 | 5 | 2 | 6-9 | 21 | 5-9 | 1-0 | 13-6 | | |
| B 10 | 5 | 7 | 3-3 | STR | | | 22-9 | | |
| B 11 | 5 | 7 | 3-0 | 21 | 1-6 | 1-6 | 21-6 | | |
| B 12 | 5 | 7 | 4-0 | 21 | 2-0 | 2-0 | 28-0 | | |
| B 13 | 5 | 6 | 8-0 | 21 | 5-3 | 2-9 | 48-6 | | |
| B 14 | 5 | 14 | 5-9 | 21 | 5-3 | 0-6 | 80-6 | | |
| B 15 | 5 | 3 | 3-3 | STR | | | 9-9 | | |
| B 16 | 5 | 8 | 8-3 | STR | | | 66-6 | | |
| B 17 | 5 | 6 | 2-9 | STR | | | 16-6 | | |
| | | | | | | | | | |
| R 1 | 5 | 6 | 7-0 | STR | | | 42-0 | | |
| R 2 | 5 | 10 | 8-3 | STR | | | 82-6 | | |
| R 3 | 5 | 8 | 3-3 | STR | | | 26-0 | | |
| R 4 | 5 | 6 | 7-0 | STR | | | 42-0 | | |
| R 5 | 5 | 32 | 8-3 | 21 | 5-6 | 2-9 | 264-0 | | |
| R 6 | 5 | 14 | 6-0 | STR | | | 84-0 | | |
| R 7 | 5 | 14 | 6-3 | STR | | | 87-6 | | |
| | | | | | | | | | |
| T 1 | 5 | 4 | 7-0 | STR | | | 28-0 | | |
| T 2 | 5 | 4 | 12-6 | STR | | | 50-0 | | |
| T 3 | 5 | 4 | 18-0 | STR | | | 72-0 | | |
| T 4 | 5 | 4 | 18-9 | STR | | | 75-0 | | |
| T 5 | 5 | 8 | 8-6 | 19 | 1-9 | 6-9 | 68-0 | | |
| T 6 | 5 | 8 | 2-6 | STR | | | 20-0 | | |
| T 7 | 5 | 8 | 3-3 | STR | | | 26-0 | | |
| T 8 | 5 | 8 | 3-9 | STR | | | 30-0 | | |
| T 9 | 5 | 8 | 4-6 | STR | | | 36-0 | | |
| T 10 | 5 | 8 | 4-9 | STR | | | 38-0 | | |
| T 11 | 5 | 16 | 5-0 | STR | | | 80-0 | | |
| T 12 | 5 | 6 | 8-9 | STR | | | 52-6 | | |
| T 13 | 5 | 32 | 8-9 | STR | | | 280-0 | | |
| T 14 | 5 | 4 | 5-0 | STR | | | 20-0 | | |
| T 15 | 5 | 12 | 18-9 | STR | | | 225-0 | | |
| T 16 | 5 | 8 | 7-9 | STR | | | 62-0 | | |

QUANTITIES (Riser Only)

STEEL Bethlehem steel, M. L.

No 5 Bars 2390 50 Ft. = 2493.3 Lbs. OK

No 7 Bars 275 75 Ft. = 363.4 Lbs. OK

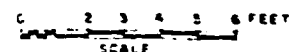
3056.7 Lbs. OK

CONCRETE

Class 4000 19.3 Cu Yds Reinforced

Note

For Construction Notes, see sheet 13.



High Stage Trash Rack
Details Sheet 15

Riser Crest Elev. 267.5

Low Stage Trash Rack
Details Sheet 16

Slide Gate and
Wall Thimble,
Details Sheet 26

Spigot Wall Fitting,
Details Sheet 17

Rock Hill Metals, Inc.

Cement 6500 Cplay

Sand 1161 Warner

Gravel (Type?) 1161 Gen'l Gravel Stone

SIDE ELEVATION

AS BUILT PLANS
Neshaminy Creek Watershed

NESHAMINY CREEK WATERSHED

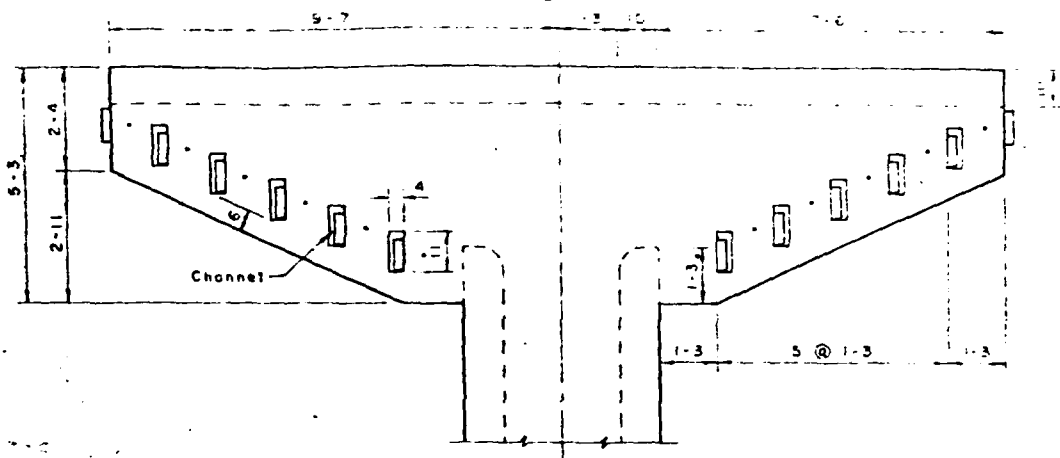
FLOODGATE RETARDING DAM PA-615

SUCKS COUNTY, PENNSYLVANIA

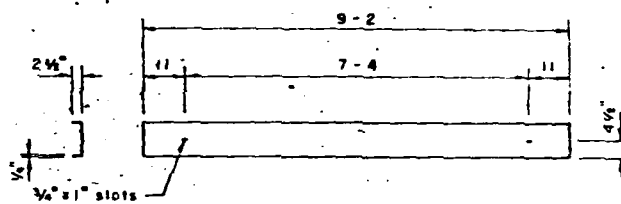
RISER STRUCTURAL DETAILS

U.S. DEPARTMENT OF AGRICULTURE

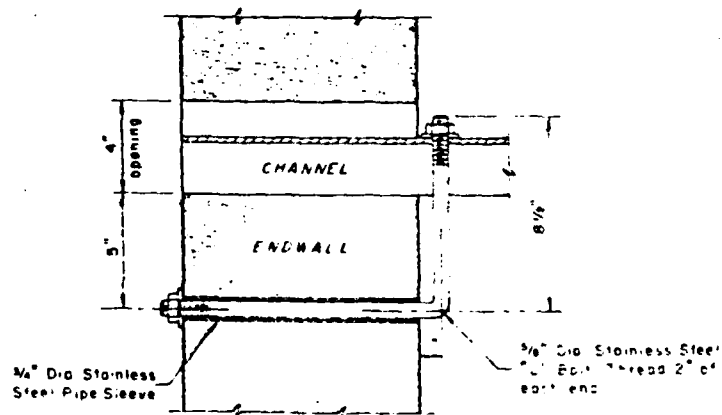
SOIL CONSERVATION SERVICE



ENDWALL ELEVATION

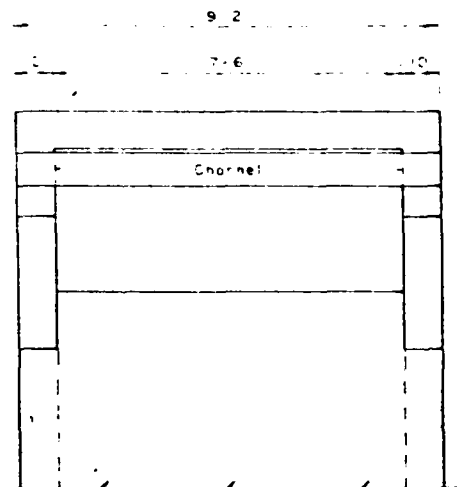


CHANNEL



"L" BOLT DETAIL

SUPPLY WITH KEY NUTS AND
FLAT WASHERS ASTM A 276
(STAINLESS STEEL)



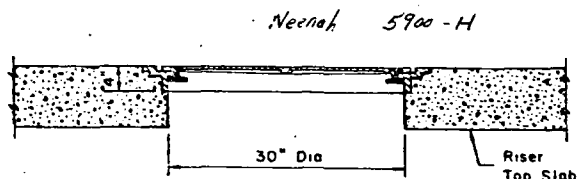
SIDEWALL ELEVATION

| BILL OF MATERIAL | | | |
|------------------|-------------|--------------|----------|
| ITEM | SIZE | LENGTH | QUANTITY |
| Channel | 2 1/2" x 9" | 9'-2" | 12 |
| Pipe Sleeve | 3/4" Dia | 0'-10" | 24 |
| "L" Bolt | 3/4" Dia | 8 1/2" x 12" | 24 |

*Rt H Metal Fabricators
3465 Nazareth Rd.
Easton, Pa.*

CONSTRUCTION NOTES

1. Channel in trash rack shall conform to Spec 581 for aluminum alloy
2. Aluminum surfaces to be placed in contact with concrete, shall be given a heavy coat of an alkali-resistant, bituminous paint before installation



MANHOLE ASSEMBLY

1. The assembly shall be grey iron casting, class 30, with a 30" opening.
2. The lifting device shall consist of a 1" dia hole approx. 3" from the outside perimeter of the lid.
3. The locking device shall consist of two rotating bars with hex bolts located under opposite edges of lid.
4. Paint in accordance with paint system A (Spec B2)

McCloskey, Phil

HIGH STAGE TRASH RACK

AS BUILT PLANS
Walter Zimmerman

NESHAMINY CREEK WATERSHED
FLOODWATER RETARDING DAM PA-615
BUCKS COUNTY, PENNSYLVANIA
RISER ACCESSORIES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

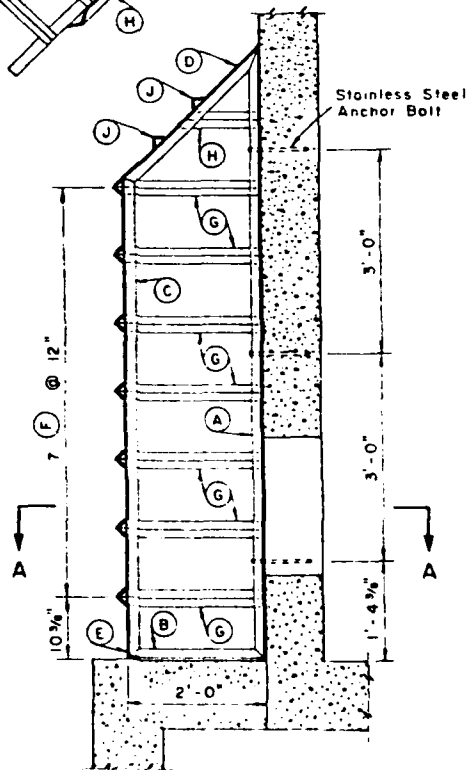
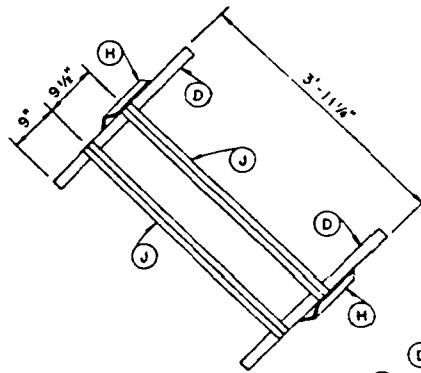
DATE: 1973 JAN 10 TIME: 10:00 AM BY: J. P. Fester

WASTE TRASH RACK BILL OF MATERIALS

| ITEM | SIZE | ENG. QTY. | MAN. QTY. |
|-------------|----------------|-------------|-----------|
| Angle (A) | 2" x 2" x 1/4" | 9 - C | 2 |
| Angle (B) | " | 2 - C | 2 |
| Angle (C) | " | 7 - C | 2 |
| Angle (D) | " | 2 - 10" | 2 |
| Angle (E) | " | 3 - 7 1/2" | 1 |
| Angle (F) | " | 4 - 2 3/4" | 7 |
| Angle (G) | " | 2 - 1 1/2" | 14 |
| Angle (H) | " | 1 - 2 1/2" | 2 |
| Angle (J) | " | 3 - 11 1/4" | 2 |
| Anchor Bolt | 1/2" Dia | 2" x 10" | 6 |

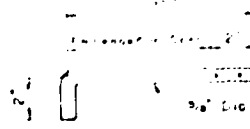
CONSTRUCTION DETAILS

1. All points of contact between angles to be welded.
2. All angles in trash rack shall conform to Spec 581 for aluminum alloy.
3. Aluminum surfaces placed against concrete surfaces, shall be given a heavy coat of an alkali-resistant paint before installation.

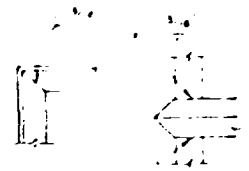


SECTION ON E

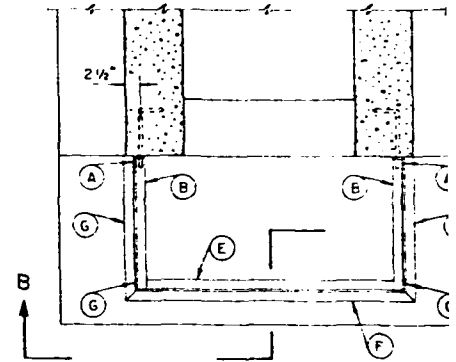
LOW STAGE TRASH RACK DETAILS



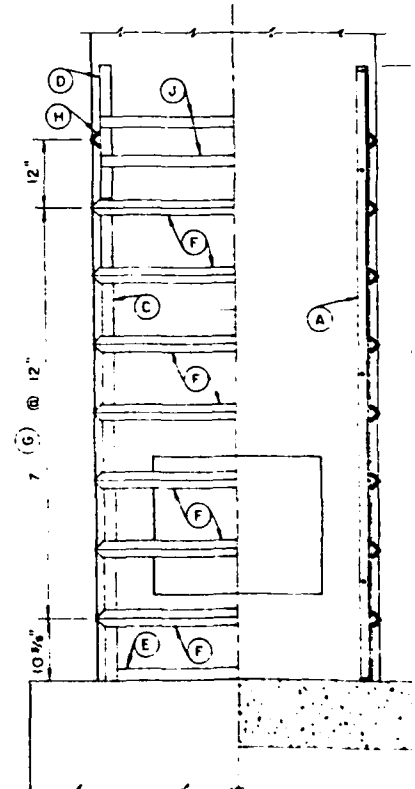
ANCHOR BOLT
SUPPLY WITH HEX NUT AND
FLAT WASHER, ASTM A-276
(STAINLESS STEEL)



WELDING DETAILS



SECTION A-A



SECTION B-B

AD-A082 668

WOODWARD-CLYDE CONSULTANTS PLYMOUTH MEETING PA
NATIONAL DAM INSPECTION PROGRAM. RAILROAD CREEK DAM (NDS ID NUM--ETC(U)
JAN 80 M F BECK, J H FREDERICK
DACW31-80-C-0018

F/8 13/13

UNCLASSIFIED

NL

2 * 2

2 1/2



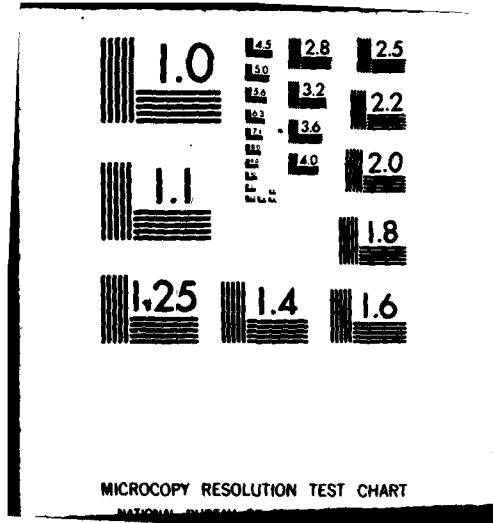
END

DATE

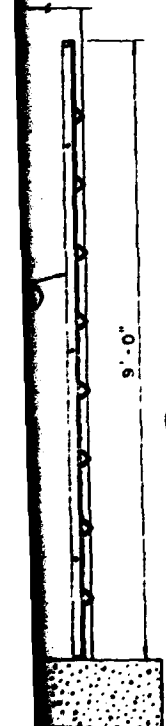
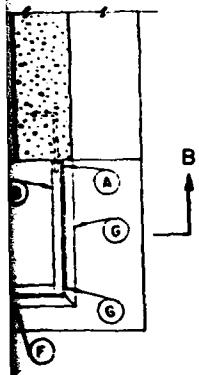
FILED

5-80

DTIC



S

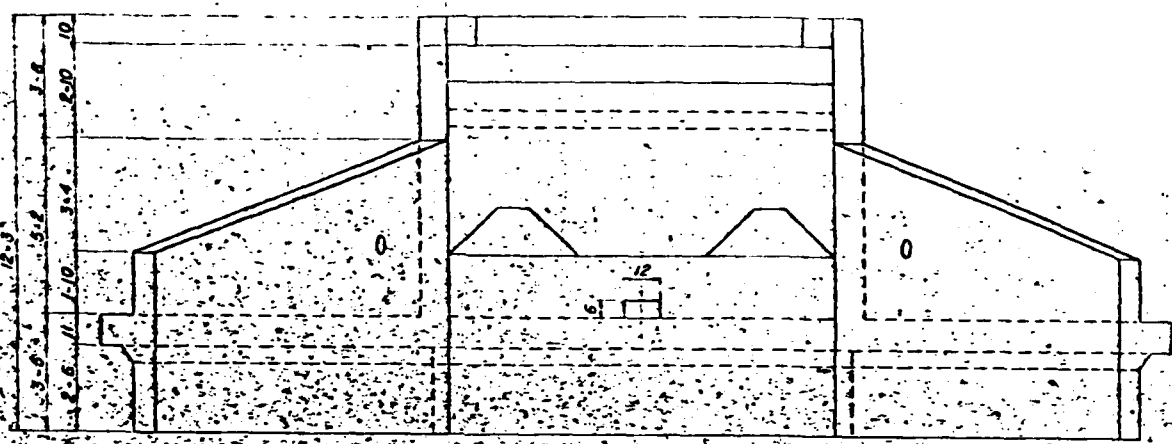


R & H Metal Fabricators
3465 Mayers Rd
Easton, Pa

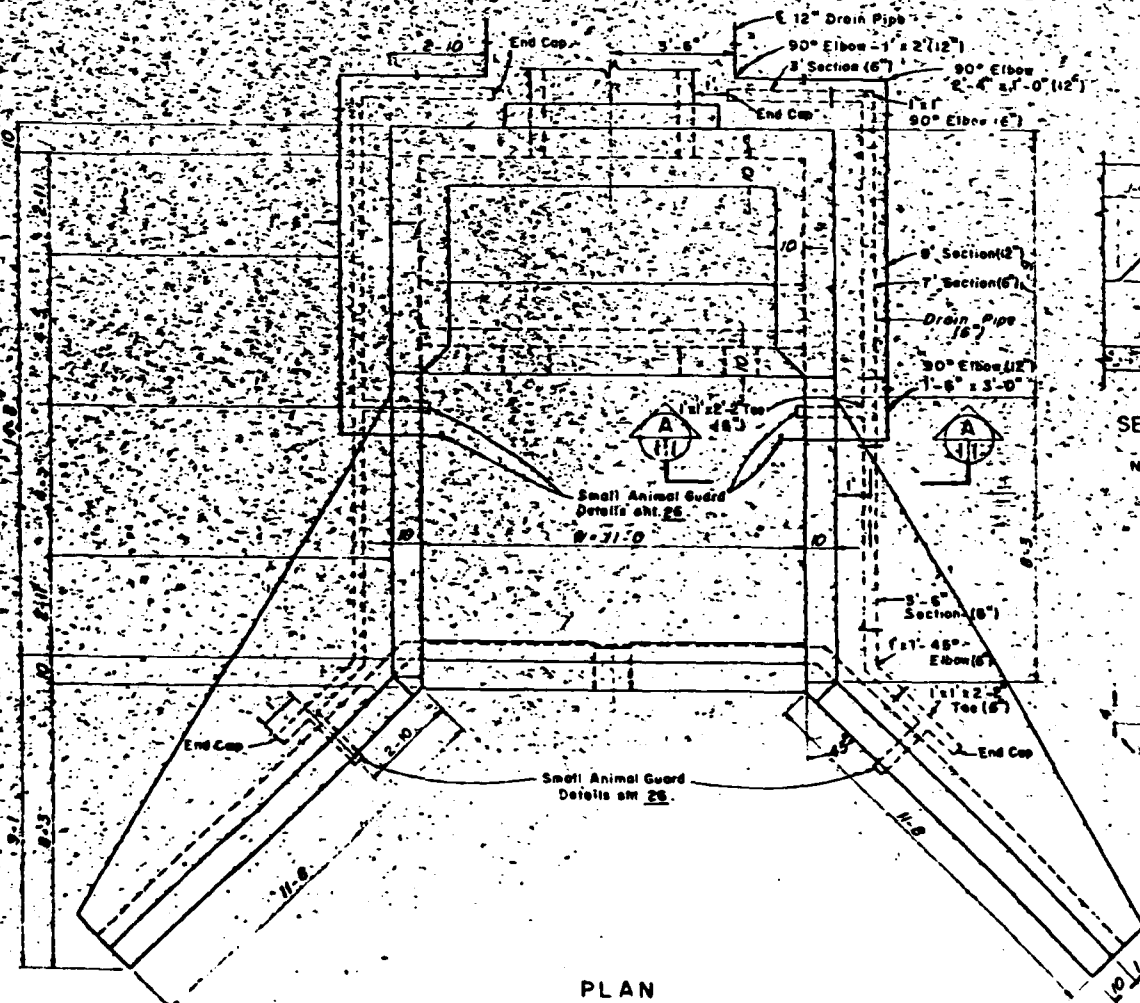
Nashua, New Hampshire

| | | |
|---------------------------------|-------------|----------|
| NESHAMINY CREEK WATERSHED | | |
| FLOODWATER RETARDING DAM PA-615 | | |
| BUCKS COUNTY, PENNSYLVANIA | | |
| LOW STAGE TRASH RACK | | |
| U.S. DEPARTMENT OF AGRICULTURE | | |
| SOIL CONSERVATION SERVICE | | |
| DATE | APPROVED BY | |
| DESIGNED BY | CHECKED BY | |
| SCALE | DATE | |
| DRAWN BY | | PA-615-P |

1/2" ESDR
not
Spec
Note LI
of cond
1016 not



DOWNSTREAM ELEVATION



PLAN

| STANDARD IMPACT BASIN | | | |
|-----------------------|--------------------------|----------------------------|--------|
| DESIGN CONSTANTS | $f_c = 4000 \text{ psi}$ | $f_c = 1500 \text{ psi}$ | |
| | $n = 8$ | $f_s = 20,000 \text{ psi}$ | |
| STANDARD DRAWING NO | ES-4110 | | |
| DATE | 1-75 | SHEET | 1 OF 5 |

CARL RORDE
Consulting Engineer
654 Ridgeway Rd. Lake George, Ore

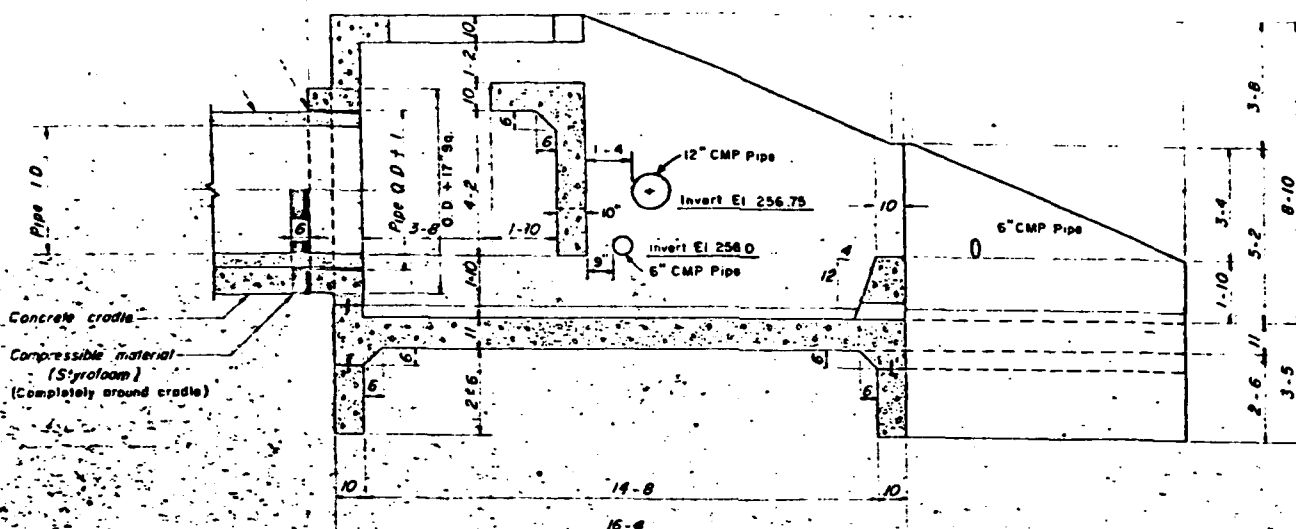
1 0 5
SCALE IN FEET
EXCEPT AS NOTED



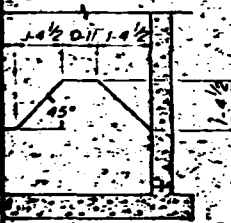
SECTION
NOT TO SCALE

PLAN
SIDE
VIEW
NOT

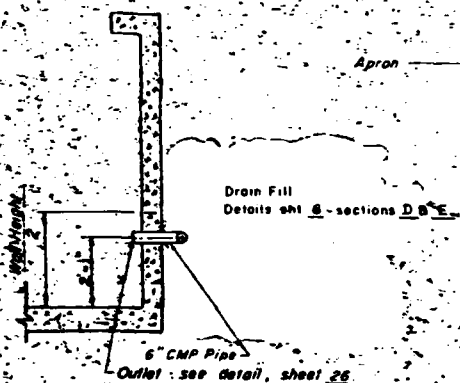
1/2" Expansion joint material, Type I, Spec 533
 Note: Last section of conduit to be laid horizontal



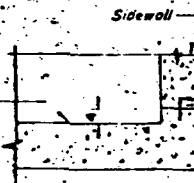
SECTION ON CENTERLINE



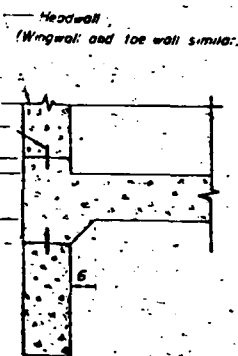
SECTION A-A
 NOT TO SCALE



SECTION THROUGH DRAIN & FILTER
 NOT TO SCALE



1/4" x 6" Carbon steel plate at E of wall Use 3" lap at splices



CONSTRUCTION JOINT DETAILS
 NOT TO SCALE

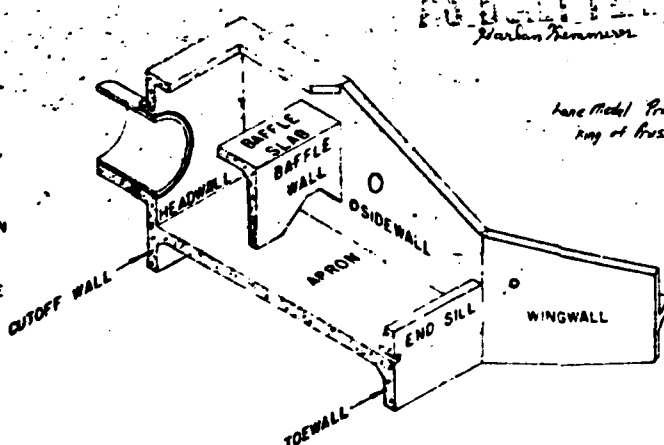
NOTE: For Construction Notes see sheet 13

QUANTITIES

| | | |
|--|-------|--------|
| Reinforced Concrete (Class 4000 Concrete) | 31.36 | cu yd |
| Reinforcing Steel | 4630 | lbs |
| Drainage | 4064 | lbs |
| 6" Drain Pipe will be Class II, Shape I, Coating A-16 gage, Perforated, Spec 531 | 56 | lin ft |
| Pipe Guard 6" Drain Pipe | 31 | lin ft |
| 1' x 1' 90° ell | 2 | each |
| 1' x 1' 45° ell | 2 | each |
| 1' x 1' 2'-2" tees | 4 | each |
| End Caps | 4 | each |
| Small Animal Guards | 4 | each |
| Joints | 4 | each |
| 1/4" x 6" Carbon steel plate, Structural grade | 680 | lbs |
| Total - \$6' | | |

AG BUILT FOR
 Harbor Hammer

have Model Products
 King of Prussia, Pa

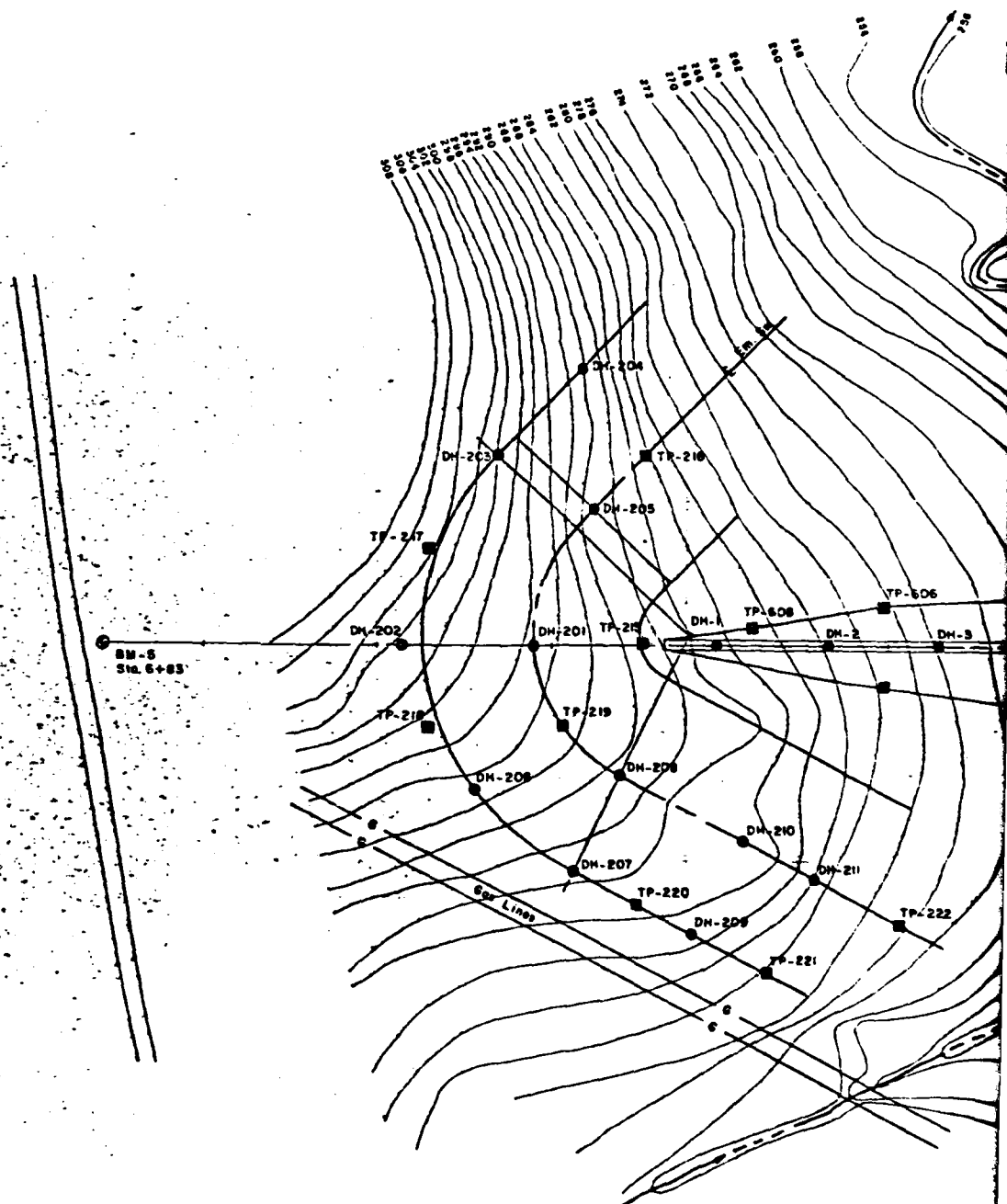


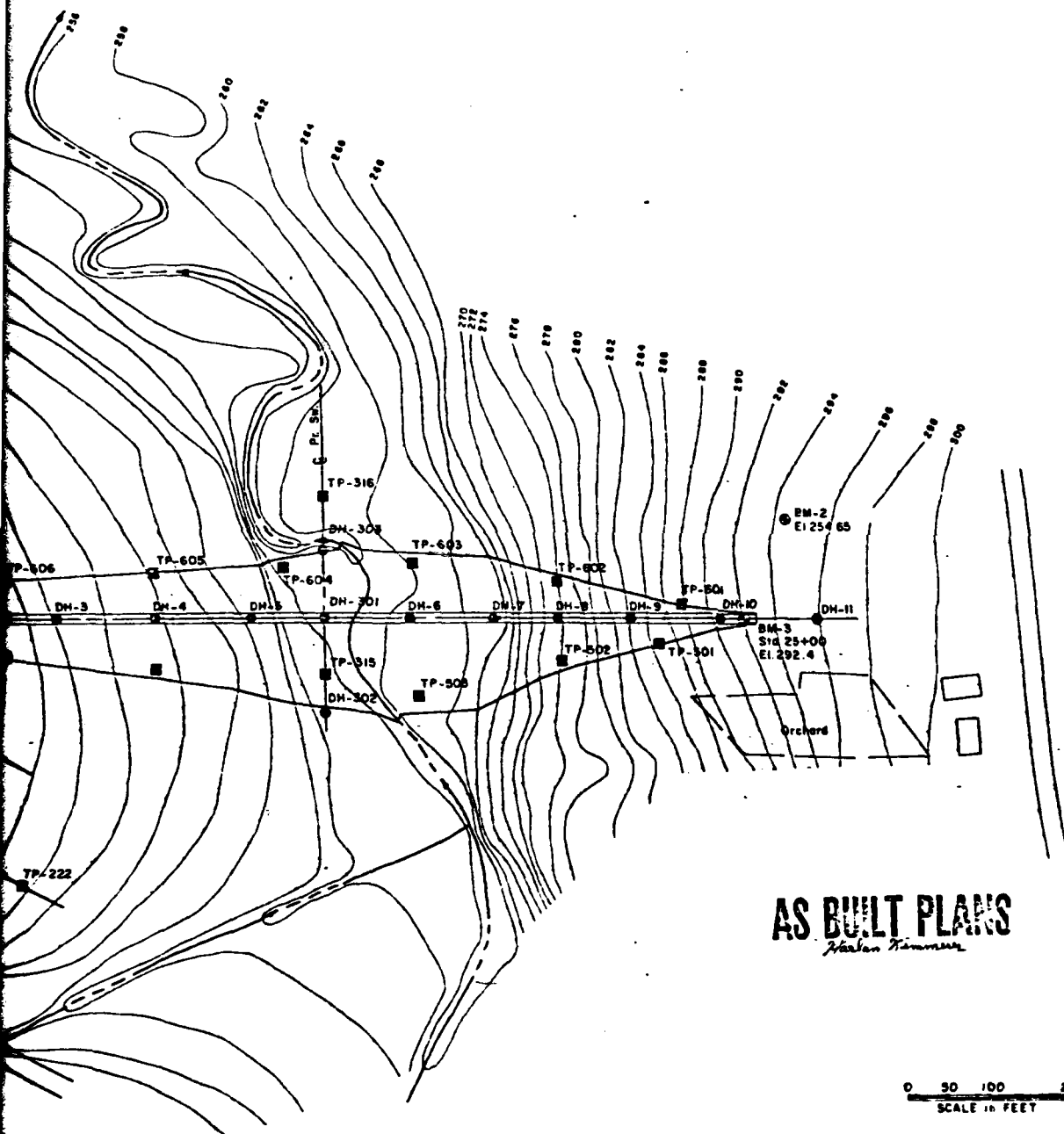
ISOMETRIC VIEW

NESHAMINY CREEK WATERSHED
 FLOODWATER RETARDING DAM PA-615
 BUCKS COUNTY, PENNSYLVANIA
 IMPACT BASIN

U S DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

| | | |
|-----------------------------|---------------------------|----------------------------|
| DESIGNED BY A. E. Fisher | DATE 11-78 | APPROVED BY [Signature] |
| DRAWN BY J. B. 2427 | CHECKED BY [Signature] | SCALE 1" = 10' |
| PROJECT NO. PA-615-P | | DATE 11-78 |





AS BUILT PLANS
Harlan Kimmner

LEGEND

- Drill Hole
- Test Pit

NOTE
 For location of Borrow Test Pits see sheet 2.
 Limits of Dam and Em. Se shown used for investigation only. Final Design see sheet 3.

**NESHAMINY CREEK WATERSHED
 FLOODWATER RETARDING DAM PA - 615
 BUCKS COUNTY, PENNSYLVANIA
 LOCATION OF TEST HOLES**

**U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE**

| | | |
|------------------|------|-------------|
| Designed | Date | Approved By |
| Drawn S. B. Dunn | 9-78 | |
| Typed | | |
| Checked | | |

LEGEND

TEST HOLE NUMBERING SYSTEM

| | |
|--------------------------------|-----------|
| Centerline of Dam | 1 - 99 |
| Borrow area | 101 - 199 |
| Emergency spillway | 201 - 299 |
| Centerline of outlet structure | 301 - 399 |
| Stream channel | 401 - 499 |
| Relief wells | 501 - 599 |
| | 601 - 699 |
| | 701 - 799 |

UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOLS

| | |
|----|---|
| GW | Well graded gravels, gravel-sand mixtures |
| GP | Poorly graded gravels |
| GM | Silty gravels, gravel-sand-silt mixtures |
| GC | Clayey gravels, gravel-sand-clay mixtures |
| SW | Well graded sands, sand-gravel mixtures |
| SP | Poorly graded sands |
| SM | Silty sands, sand-silt mixtures |
| SC | Clayey sands, sand-clay mixtures |
| ML | Silts, silty, very fine sands, sandy or clayey silts |
| CL | Clays of low to medium plasticity, silty, sandy or gravelly clays |
| CH | Clays of high plasticity, fat clays |
| MH | Elastic silts, amorphous or diatomaceous silts |
| OL | Organic silts and organic silty clays of low plasticity |
| OH | Organic clays or silts of medium to high plasticity |

BEDROCK SYMBOLS

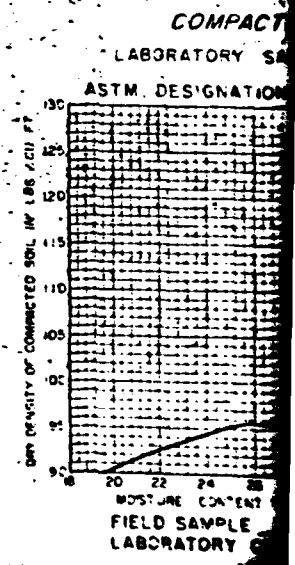
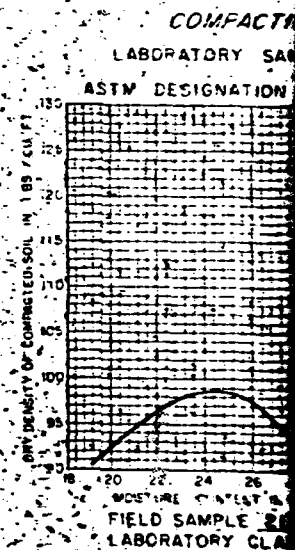
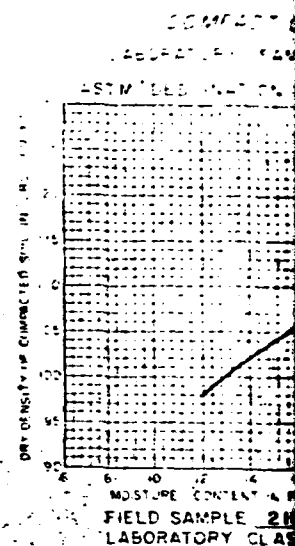
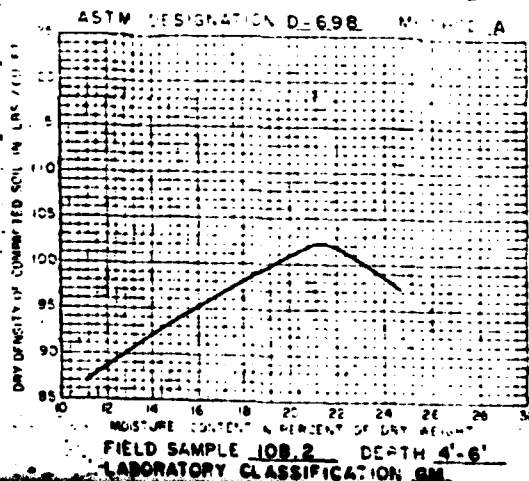
| | | | |
|----|-----------|----|-----------|
| B | Basalt | Sc | Schist |
| Gn | Gneiss | Sh | Shale |
| Gr | Granite | Ss | Siltstone |
| Ls | Limestone | Sl | Slate |
| Ma | Marble | Ss | Sandstone |

SAMPLES

| | |
|----|-------------|
| DB | Disturbed |
| US | Undisturbed |

COMPACTION CURVE

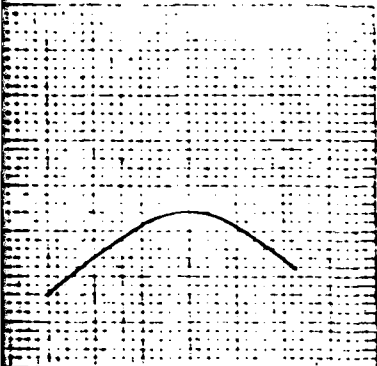
LABORATORY SAMPLE NO 73W208



COMPACTION CURVE

LABORATORY SAMPLE NO 73W203

TEST METHOD D-698 METHOD A

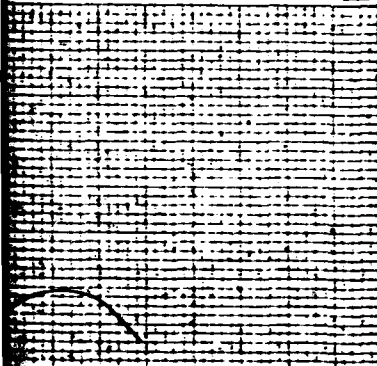


FIELD SAMPLE 216.1 DEPTH 17'-6"
LABORATORY CLASSIFICATION CL

COMPACTION CURVE

LABORATORY SAMPLE NO 73W204

TEST METHOD D-698 METHOD A

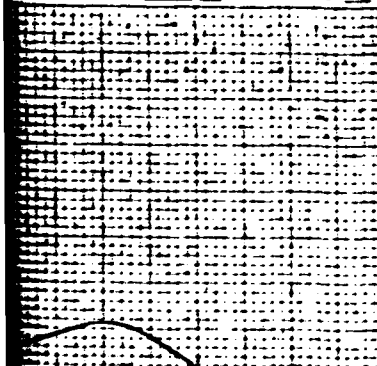


FIELD SAMPLE 217.1 DEPTH 1'-3"
LABORATORY CLASSIFICATION ML

COMPACTION CURVE

LABORATORY SAMPLE NO 73W205

TEST METHOD D-698 METHOD A

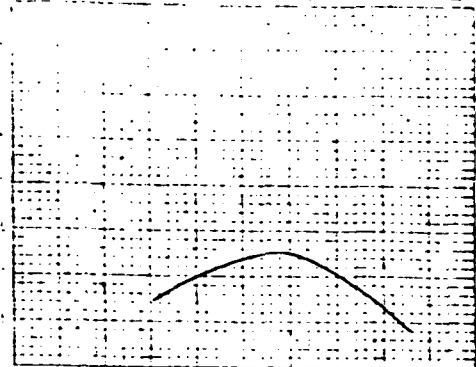


FIELD SAMPLE 217.2 DEPTH 3'-5"
LABORATORY CLASSIFICATION GM

COMPACTION CURVE

LABORATORY SAMPLE NO 73W206

TEST METHOD D-698 METHOD A

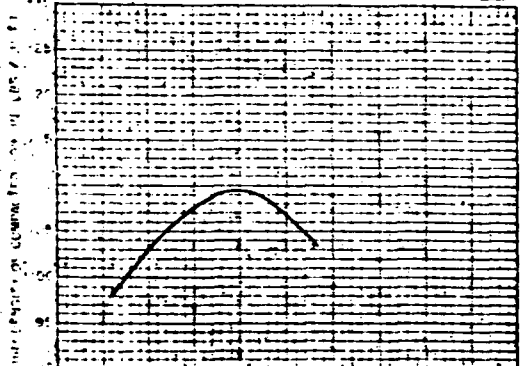


FIELD SAMPLE 217.3 DEPTH 5'-12.8"
LABORATORY CLASSIFICATION GW

COMPACTION CURVE

LABORATORY SAMPLE NO 73W207

ASTM DESIGNATION D-698 METHOD A



FIELD SAMPLE 108.1 DEPTH 0.6'-4"
LABORATORY CLASSIFICATION CL

NOTE

All soil and rock classifications were determined by visual examination, except where otherwise noted.

NESHAMINY CREEK WATERSHED

FLOODWATER RETARDING DAM PA - 615

BUCKS COUNTY, PENNSYLVANIA

COMPACTION DATA

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

| | |
|-------------|-------------|
| Date | Approved by |
| Designed by | Checked by |
| Drawn by | Field No. |
| Tested by | Location |
| Reviewed by | Project No. |

APPENDIX

F

SITE GEOLOGY RAILROAD CREEK DAM

The Railroad Creek Dam is located in the Triassic Lowland Section of the Piedmont Physiographic Province. As shown in Plate F-1, the dam is underlain by the Triassic age Lockatong Formation which consists of gray or red argillite and siltstone. Immediately south of the dam lie shale and arkose of the Stockton Formation. These two rock formations are in fault contact with each other. The faults strikes near east-west passing near the right abutment and has been mapped for over a distance of 25 miles across Bucks and Montgomery Counties. Bedding in the emergency spillway area strikes west-north-west, dipping 40 degrees to the south (downstream direction). Rock jointing predominantly strikes to the north-east with high angle dips. Information contained in SCS files states that the dam in general is underlain by moderately soft argillite and siltstone weathered to a depth of less than ten to over 25 feet. The weathered rock was overlain by approximately 6 feet of residual soil. Localized swampy areas were described in the alluvial deposits of the flood plain.

